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A Dynamic Adaptive Risk Management (DARM) Framework for Managing Black Swan Events and Emerging Risks in Complex Project Environments

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Abstract **Original Research Article**

Projects today face a category of risk that most formal management systems were never built to handle. Rare, high-impact events that arrive without warning and resist meaningful prediction have become a genuine feature of the project landscape, not an occasional anomaly. Despite decades of refinement, mainstream project risk management continues to operate on the assumption that careful planning and structured risk registers will capture what can go wrong. For the class of events this paper examines, that assumption simply does not hold. The paper identifies five structural weaknesses in conventional risk management and proposes the Dynamic Adaptive Risk Management (DARM) framework as a direct response. DARM integrates four theoretical traditions: Complexity Theory, Resilience Engineering, High-Reliability Organization Theory, and Dynamic Capabilities Theory. These are brought together into a four-layer operational model built around a continuous cycle of Sensing, Assessing, Responding, and Learning, supported by five foundational enablers and oriented toward five desired outcomes. The central argument is that resilience to rare, extreme disruption is not built through more accurate prediction. It is built through the organizational capacity to detect early signals, adapt quickly when surprises arrive, and grow stronger from every disruption survived.

Keywords: Black Swan events, dynamic risk management, project complexity, organizational resilience, adaptive capacity, emerging risk, DARM framework.

1. INTRODUCTION

Something has shifted in the environment in which projects are delivered. The disruptions that have derailed major projects over the past two decades do not fit neatly into the risk categories that project managers are trained to anticipate. A global pandemic, cascading supply chain failures, sudden geopolitical realignments, and large-scale cyberattacks arrived without meaningful warning, spread in ways that were difficult to trace, and looked obvious only once the damage was done. Taleb (2007) gave this class of event its most widely recognized name: the Black Swan. His description captures three qualities with unusual precision. These events are statistically rare, they carry disproportionate impact, and they are rationalized as predictable only in hindsight by people who had no idea they were coming.

The challenge this creates for project management is not simply that such events are hard to foresee. It is that dominant risk management frameworks are structurally designed for a different kind of uncertainty. Tools like the PMBOK risk register, ISO 31000 processes, and standard quantitative analysis techniques work well when risks are identifiable, historically grounded, and probabilistically tractable. They were not designed for situations where the shape of the problem is unknown, historical frequency data does not exist, and standard risk categories provide a false sense of coverage rather than real protection (Kutsch and Hall, 2010; Ramasesh and Browning, 2014).

This paper pursues three objectives. First, it identifies and articulates what exactly breaks down in conventional risk management when it encounters Black Swan events and emerging risks. Second, it explains, drawing on Complexity Theory, Resilience Engineering, High-Reliability Organization Theory, and Dynamic Capabilities Theory, why those weaknesses are structural rather than incidental. Third, and most centrally, it proposes the DARM framework as a practical and theoretically grounded alternative. The paper is structured as follows. Section 2 reviews the relevant literature. Section 3 develops a five-part critique of conventional approaches. Section 4 presents the DARM framework in full. Section 5 discusses theoretical and practical implications. Sections 6 and 7 address limitations and conclusions.

2. LITERATURE REVIEW

2.1 Black Swan Events and the Problem of Deep Uncertainty

Taleb's (2007) contribution was not simply to name difficult events but to identify a cognitive failure that makes organizations repeatedly unprepared for them. Risk management frameworks share the human tendency to explain the world in terms of patterns that have already occurred. When something has no precedent, the risk management process itself, by appearing thorough, can create a false sense of security that delays response even when early signals begin to appear.

Knight (1921) drew the foundational distinction between risk, where probabilities can be estimated, and uncertainty, where they cannot. Black Swan events fall on the uncertainty side of that line. In project management, Loch et al. (2006) describe genuinely unforeseeable contingencies as unknown unknowns, noting that conventional planning tools are not designed to accommodate situations where the structure of the problem is unknown in advance. Ramasesh and Browning (2014) show that risk registers consistently underrepresent this category not because project managers are careless, but because the structure of a register makes it impossible to include what no one has yet imagined. Sanderson (2012) extends this critique to governance frameworks, questioning whether uncertainty can ever be rendered finite through upfront analysis.

Complexity Theory adds another layer. Project environments characterized by tight coupling, nonlinear interdependencies, and emergent behavior produce outcomes that are difficult to anticipate even when individual components are well understood (Cooke-Davies *et al.,* 2007; Geraldi *et al.,* 2011). Perrow (1984) argued that in complex, tightly coupled systems, failures are not aberrations but structural inevitabilities over a long enough time horizon. The implication is sobering: as projects become more interconnected and technologically dense, exposure to rare, high-impact disruption grows, even as the analytical frameworks used to manage it remain oriented toward the more tractable end of the risk spectrum.

2.2 Conventional Project Risk Management: What It Assumes

The dominant frameworks for project risk management share a common sequential architecture: identify risks, assess likelihood and impact, plan responses, and monitor progress (Project Management Institute, 2021; International Organization for Standardization, 2018). For risks that recur across projects, have documented frequency distributions, and fit within the experience of the project team, this architecture delivers genuine value. Hillson (2009) and Chapman and Ward (2003) have documented those benefits extensively.

The problem arises at the boundary of what these frameworks were designed for. Pich et al. (2002) distinguish between variation, foreseen uncertainty, and unforeseen uncertainty, arguing that most formal methods address the first two categories and treat the third with generic contingency provisions that provide financial buffer without addressing the actual nature of the uncertainty. Kutsch and Hall (2010) found empirically that project managers often respond to risks they cannot meaningfully analyze through deliberate inattention, a behavior that the rigid structure of a risk register can inadvertently encourage. Aven (2016) has argued from a risk science perspective that overreliance on probability as a tool for representing uncertainty has itself become a source of systematic error, particularly where the most consequential events are least amenable to probabilistic characterization.

2.3 Resilience Engineering and High-Reliability Organization Theory

Resilience Engineering offers a fundamentally different starting point. Rather than trying to anticipate and eliminate all possible failure modes, the goal is to build organizations that can absorb disruption and adapt their functioning without catastrophic breakdown (Hollnagel *et al.,* 2006). Woods (2015) frames this as a shift from Safety-I, which focuses on preventing specific bad outcomes, to Safety-II, which focuses on sustaining good outcomes under varying and unpredictable conditions. The practical difference is significant: Safety-I organizations invest in preventing identifiable failure modes; Safety-II organizations invest in general adaptive capacity regardless of the form disruption takes.

High-Reliability Organization (HRO) Theory provides the most instructive practical examples. Weick and Sutcliffe (2015) studied institutions, including nuclear power plants, aircraft carrier flight decks, and wildland firefighting crews, that manage dangerous technologies with low rates of catastrophic failure. Five characteristics recur: a preoccupation with failure that treats near-misses as information; a reluctance to simplify explanations; sustained sensitivity to operational reality; commitment to bouncing back quickly; and willingness to let decisions migrate to whoever has the most relevant expertise. These are not planning artefacts. They are organizational capabilities maintained through practice.

2.4 Dynamic Capabilities Theory and Organizational Adaptation

The Dynamic Capabilities framework developed by Teece (2007) examines how organizations sustain performance in environments that change faster than any fixed strategy can anticipate. His answer centers on three meta-capabilities: sensing changes in the environment before they fully materialize, seizing opportunities or responding to threats as they emerge, and reconfiguring internal resources and routines in response. While developed in a strategic management context, this logic maps naturally onto project risk management under deep uncertainty. Sensing weak signals, assessing uncertain conditions without waiting for full information, and reconfiguring response capacity quickly are precisely what Black Swan exposure demands.

Organizational Learning Theory adds the temporal dimension. Argyris and Schon (1978) distinguish between single-loop learning, which corrects deviations from a plan, and double-loop learning, which questions whether the plan's underlying assumptions remain valid. Conventional risk management is predominantly single-loop: it monitors against a register and triggers pre-planned responses. Double-loop learning, by contrast, would prompt an organization experiencing unexpected disruption to ask not only how to respond but whether its entire model of the risk landscape needs revision. Building that reflective capacity into project risk management is one of the core ambitions of the DARM framework. Flyvbjerg et al. (2003) found systematic patterns of overrun and delay in megaprojects that conventional risk management failed to prevent, attributing this partly to the absence of mechanisms for updating risk judgements as new information emerged during delivery.

2.5 Synthesis: What the Literature Points Toward

The four bodies of literature reviewed above converge on a consistent conclusion. Managing Black Swan events and emerging risks requires a fundamentally different kind of risk management capability from what conventional frameworks provide. It requires continuous environmental sensing rather than periodic risk identification. It requires honest reasoning under uncertainty rather than forced probabilistic quantification. It requires adaptive, decentralized governance rather than fixed escalation hierarchies. And it requires deliberate learning mechanisms that convert disruption into capability. The gap this paper addresses is the absence, despite this theoretical convergence, of an integrated operational framework that brings these requirements together in a form that practitioners can apply directly.

3. Critique of Current Risk Management Approaches

3.1 The Predictive Fallacy

When a project team completes a risk register, the document implies that the relevant universe of risks has been mapped. Checklists, lessons-learned databases, and expert workshops reinforce that impression. But the events that define Black Swan risk are, by definition, outside the perceptual horizon of the people constructing the register. The thoroughness of the process does not expand that horizon; it documents what was already knowable. The danger is not only that certain risks are missed but that the identification process provides false reassurance that nothing important has been omitted.

3.2 Front-Loaded Planning in a Changing Environment

Standard methodologies concentrate the most intensive analytical effort at project initiation and planning. Risk monitoring during execution tends to be a lighter, periodic activity focused on tracking the original register rather than re-examining whether that register remains adequate. In stable environments, this may be defensible. In complex, fast-evolving projects, it is not. Risks emerge, mutate, and intensify throughout the life of a project, and the risk landscape at completion may bear little resemblance to the one mapped at initiation (Geraldi *et al.,* 2011). A framework that treats its initial assessment as its primary analytical contribution cannot respond to risks that emerge after planning ends.

3.3 Forcing Deep Uncertainty into Probabilistic Structures

Probability-impact matrices and Monte Carlo simulations are legitimate tools when applied to risks with credible probability distributions. The problem arises when they are applied to risks characterized by deep uncertainty, where the outcome space is not fully defined and historical data provides little guidance (Aven, 2016; Ramasesh and Browning, 2014). In those circumstances, attaching a probability estimate does not produce rigorous analysis. It produces analysis that looks rigorous while being epistemically groundless. Taleb (2007) calls this the Ludic Fallacy: the tendency to model real-world uncertainty using the clean probability structures that work in games and laboratories. The consequence is that the risks most likely to be underestimated are precisely the rare, high-consequence ones that probabilistic frameworks handle least well.

3.4 Governance Structures That Cannot Move Fast Enough

Project governance in large organizations typically involves layered approval processes and formal escalation procedures designed to ensure accountability. Under conditions of rapid, unexpected disruption, these structures often become the primary obstacle to an effective response. Weick and Sutcliffe (2015) found that high-reliability organizations deliberately redesign authority structures during crisis conditions, moving decision-making toward the people with the most relevant operational knowledge rather than requiring all decisions to flow upward through a fixed hierarchy. Conventional project governance rarely includes this contextual flexibility, meaning that an organization may detect an emerging threat and still be unable to respond at the necessary speed.

3.5 Learning That Does Not Accumulate

Post-project reviews are the primary mechanism through which conventional risk management converts experience into knowledge. In practice, these reviews are frequently under-resourced, conducted too long after events for accurate recall, and poorly connected to subsequent planning processes (Williams, 2008). When a major unexpected disruption occurs, the organization responds, absorbs the cost, and moves on. The specific ways in which its risk management framework failed to surface the threat are not systematically examined. The result is that each new project begins with essentially the same assumptions as the last one, even if the last one included a significant encounter with exactly the kind of uncertainty that conventional frameworks handle poorly.

4. The Dynamic Adaptive Risk Management (DARM) Framework

4.1 Overview of the Integrated DARM Framework

The Dynamic Adaptive Risk Management (DARM) framework is built as a direct response to the five structural limitations identified in Section 3. It does not offer incremental improvements to existing practice. It reconceives risk management itself, shifting it from a discrete planning exercise completed at project initiation to a continuous organizational capability that operates throughout the life of the project.

As illustrated in Figure 2, the framework integrates four components into a single adaptive system. At its center is a continuous operational cycle of Sense, Assess, Respond, and Learn. This cycle is operationalized through four functional layers, each corresponding to one stage of the cycle. Five foundational enablers provide the organizational conditions necessary to sustain the cycle under pressure. And five desired outcomes define what the framework is designed to achieve. These four components are not independent elements assembled side by side. They function as an integrated whole, with each part reinforcing and depending on the others.

The theoretical architecture of DARM draws on four established scholarly traditions, each contributing a distinct dimension to the framework. Complexity Theory informs the framework's recognition that project environments are nonlinear, tightly coupled, and prone to emergent behaviour that cannot be fully anticipated. Resilience Engineering contributes the emphasis on adaptive capacity rather than predictive control, and the principle that organizational strength is measured by how well a system functions under stress rather than how completely it avoids failure. High-Reliability Organization Theory provides the specific organizational practices: preoccupation with failure, sensitivity to operations, deference to expertise, and the design of decision structures that can flex under crisis conditions. Dynamic Capabilities Theory supplies the temporal logic: sensing, seizing, and reconfiguring as a continuous cycle rather than a one-time planning event. Taken together, these four traditions produce a framework that is theoretically grounded, practically oriented, and designed for the specific conditions that Black Swan events create.

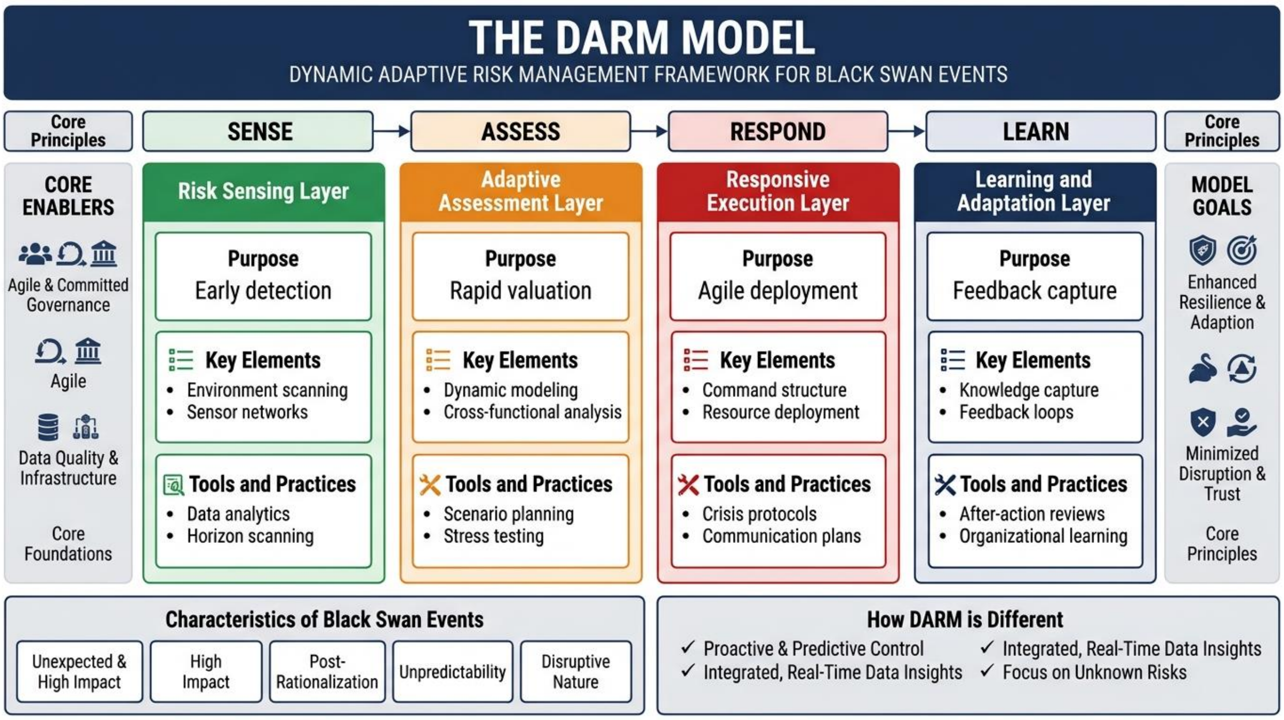

Figure 2. The Integrated Dynamic Adaptive Risk Management (DARM) Framework, showing foundational enablers, the four-layer operational architecture, the continuous operational cycle, and desired organizational outcomes as a single integrated adaptive system.

4.2 The Continuous Operational Cycle: Sense, Assess, Respond, Learn

At the core of the DARM framework is a four-stage operational cycle that runs continuously throughout the project lifecycle. As illustrated in Figure 1, the four stages are Sense, Assess, Respond, and Learn. These are not sequential phases completed one after another. They operate simultaneously and feed into each other without pause. Sensing is always occurring in the background, even when a response is already underway. Learning begins as soon as a disruption starts to resolve and feeds directly into the next round of sensing. The cycle has no natural stopping point.

The Sense stage involves the early detection of indicators of emerging threats before those threats have fully materialized. The Assess stage interprets what sensing surfaces, distinguishing genuine signals from background noise and forming actionable judgements under conditions where certainty is unavailable. The Respond stage moves from judgement to action, implementing agile, proportionate responses while maintaining critical project functions. The Learn stage closes the loop, capturing what the organisation has discovered through the disruption and reinvesting that learning into the sensing capacity of the next cycle. Each pass around the cycle leaves the organisation slightly better prepared than it was before.

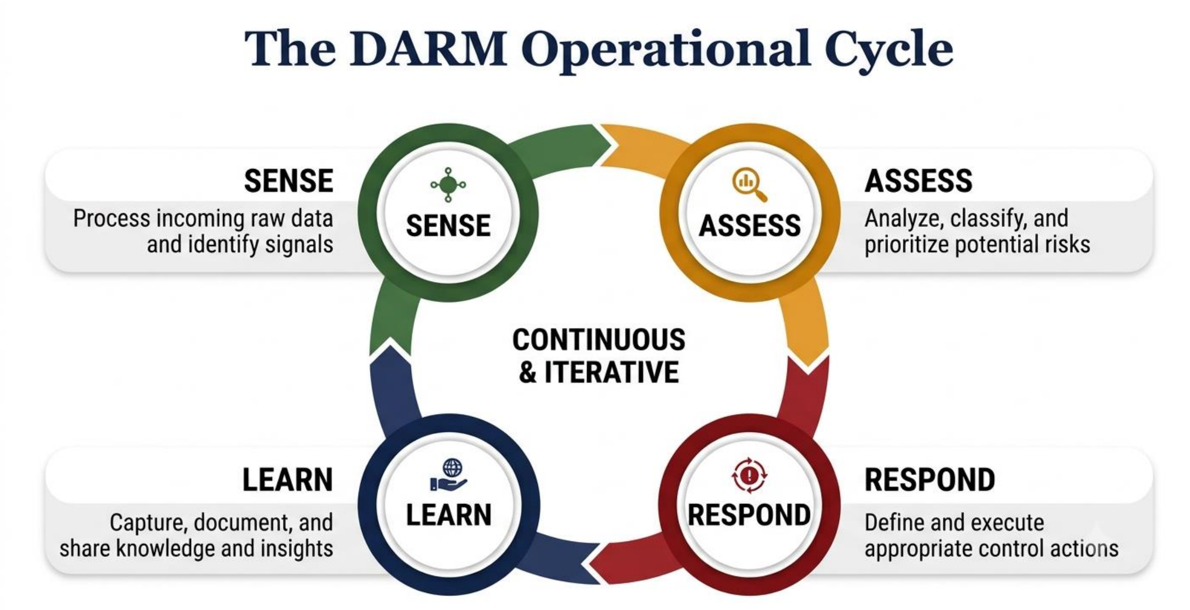

Figure 1: The DARM Operational Cycle: A continuous, four-stage process of Sense, Assess, Respond, and Learn, running iteratively throughout the project lifecycle

4.3 The Four Operational Layers

The operational cycle is made concrete through four structural layers, each corresponding to one stage of the cycle. Table 1 summarizes the purpose, key elements, tools and practices, and expected output of each layer. The layers are described in detail below, with explicit reference to Figure 2 throughout.

Table 1: The Four Operational Layers of the DARM Framework: Purpose, Key Elements, Tools and Practices, and Expected Output

Layer	Purpose	Key Elements	Tools and Practices	Expected Output
1. Risk Sensing Layer	Identify weak signals, emerging trends, and potential disruptions before they escalate.	Environmental scanning; trend and horizon monitoring; weak signal detection; stakeholder intelligence; anomaly identification.	PESTLE scanning; big data analytics; social listening; expert networks; leading indicators.	An expanded perceptual horizon: emerging threats surfaced earlier and more completely than conventional risk registers allow.
2. Adaptive Assessment Layer	Assess the nature, likelihood, and impact of emerging and high-uncertainty risks.	Scenario exploration; dynamic risk assessment; uncertainty and sensitivity analysis; systems and interdependency mapping; emerging risk prioritisation.	Scenario planning; Monte Carlo simulations; causal loop diagrams; bow-tie analysis; impact mapping.	Structured, scenario-based risk judgements that are epistemically honest about what is and is not knowable under deep uncertainty.

3. Responsive Execution Layer	Implement agile responses, maintain critical functions, and minimise disruption.	Rapid decision-making; contingency activation; flexible resource reallocation; crisis coordination; adaptive governance and escalation.	Playbooks and contingencies; war room command centre; agile methods; real-time dashboards; stakeholder alignment.	Rapid, coordinated responses that maintain critical project delivery even during confirmed disruption events.
4. Learning and Adaptation Layer	Capture lessons, strengthen capabilities, and improve preparedness for future unknowns.	After-action reviews; lessons-learned capture; knowledge integration; capability and resilience building; continuous improvement.	Retrospectives; knowledge repositories; training and simulations; resilience metrics; policy and process updates.	Progressively strengthened risk sensing capability, with each disruption cycle expanding the organization's capacity to detect and respond to future threats.

The Risk Sensing Layer, shown on the left side of Figure 2, is where DARM most sharply departs from conventional practice. Where a standard risk register captures risks that project team members can already articulate, the sensing layer is designed to surface what is not yet articulable. Continuous environmental scanning, across technological, social, regulatory, and stakeholder environments, uses tools such as PESTLE analysis, social listening platforms, and expert horizon-scanning networks to widen the organization's perceptual field so that emerging anomalies can be noticed before they become crises. The goal is not to predict specific events but to extend the organization's perceptual range into territory that conventional registers cannot reach.

The Adaptive Assessment Layer, the second layer in Figure 2, takes what the sensing layer surfaces and makes sense of it under genuine uncertainty. The critical design principle is that it does not force uncertain signals into false probabilistic structures. Scenario planning, causal mapping, and systems and interdependency analysis develop a range of possible interpretations and trajectories for each emerging threat, substituting structured uncertainty reasoning for the false precision of probability estimates. This directly addresses the limitation identified in Section 3.3.

The Responsive Execution Layer translates assessment into action. When a threat has been assessed as requiring a response, this layer provides rapid, coordinated structures: pre-developed playbooks, command center arrangements that concentrate relevant expertise, and agile resource reallocation mechanisms. As illustrated in Figure 2, the governance design within this layer builds in the contextual flexibility that conventional hierarchical governance lacks, creating a dual-mode arrangement where normal decision pathways apply under ordinary conditions and a more decentralized, expertise-led structure activates during confirmed disruptions.

The Learning and Adaptation Layer, the fourth layer in Figure 2, transforms disruption experience into organizational capability. Rather than treating the after-action review as an administrative formality, this layer treats it as the primary mechanism through which resilience improves over time. Lessons captured are fed directly back into the sensing layer, progressively expanding the range of signals the organization is prepared to notice and act upon. This ensures that DARM improves with each disruption cycle rather than resetting to its original state.

4.4 Foundational Enablers

As shown on the left panel of Figure 2, five foundational enablers determine whether an organization can operationalize the DARM cycle in practice. These are not aspirational values but concrete organizational conditions, each of which must be in place for the corresponding layers of the framework to function.

Leadership and culture is the first and most fundamental enabler. No analytical sophistication in the assessment layer will produce useful outcomes if the organizational culture punishes the people who surface uncomfortable signals. Risk-aware leadership, psychological safety for frontline reporting, and genuine openness to early warning information are prerequisites for effective sensing. Weick and Sutcliffe (2015) found this cultural dimension to be decisive in distinguishing high-reliability organizations from those that experience catastrophic failures despite having adequate technical systems.

Information and transparency is the second enabler. Weak signals detected at the operational level need to reach people with the authority and expertise to act on them. In many large project organizations, this flow is blocked by reporting structures or political considerations. Stakeholder collaboration, the third enabler, extends the organization's sensing range into the networks of suppliers, regulators, communities, and partner organizations that surround the project. Many of the most consequential emerging risks originate in these interorganizational dependencies rather than within the project itself.

Digital and analytics infrastructure, the fourth enabler, is a practical prerequisite for making the sensing and assessment layers operational at scale. The fifth enabler, governance and accountability, ensures that the adaptive, decentralized decision-making that the Responsive Execution Layer calls for during crisis conditions coexists with the clear roles, decision rights, and audit trails that project governance requires. This balance is achievable through deliberate dual-mode governance design but does not emerge automatically from standard project governance arrangements.

4.5 Desired Outcomes

The five desired outcomes shown on the right panel of Figure 2 define what the framework is designed to achieve and provide the criteria against which its practical effectiveness should ultimately be assessed.

Enhanced resilience is the foundational outcome from which the others follow: the ability to absorb shocks without catastrophic breakdown, adapt in real time as conditions change, and emerge from each disruption with strengthened capacity for the next. Better decision quality flows from the framework's commitment to honest uncertainty reasoning and real-time situational awareness, enabling more informed and timely choices throughout the project lifecycle. Operational continuity refers to the ability to maintain delivery of critical project objectives even when significant disruption occurs, through the contingency activation mechanisms in the Responsive Execution Layer.

Stakeholder confidence, often overlooked in risk management frameworks, carries substantial practical significance. Clients, funders, and partner establishments that can see evidence of a genuinely robust risk management capability are more likely to maintain their commitment during periods of disruption, reducing the secondary legislative risks that can compound the impact of a primary event. Long-term value creation is the cumulative expression of all four: organizations that build genuine resilience to rare, high-impact disruption develop an adaptive capacity that becomes a durable competitive advantage, particularly in sectors where project environments are becoming more complex and disruptions more frequent.

4.6 The Novel Contribution of DARM

DARM differs from existing frameworks in ways that go beyond presentational choice. ISO 31000 and the risk management processes embedded in the PMBOK Guide are sequential, plan-driven, and premised on the assumption that risks can be identified with reasonable completeness at the outset of a project. DARM rejects that premise as inadequate for the specific category of risk it is designed to address. Table 2 makes the comparison explicit across five dimensions that directly correspond to the structural limitations identified in Section 3.

Table 2: Conventional Project Risk Management Compared with the DARM Framework Across Six Key Dimensions

Dimension	Conventional Risk Management	DARM Framework
Information Basis	Relies on historical data and pre-identified risk categories; bounded by the prior experience of the project team.	Focuses on weak signals and emerging patterns; designed to surface risks that have no historical precedent through continuous environmental scanning.
Planning Orientation	Front-loaded and plan-driven; risk register fixed at project initiation and treated as the primary reference throughout delivery.	Continuous and iterative; risk management is active throughout the project lifecycle, with each cycle of sensing and learning refining the next.
Treatment of Uncertainty	Forces risks into probabilistic structures even where credible probability distributions cannot be constructed, creating an illusion of precision.	Explicitly designed for deep uncertainty; uses scenario-based reasoning and sensitivity analysis rather than probability estimates when data does not support them.
Governance Structure	Centralised and hierarchical; escalation pathways remain fixed regardless of the urgency or nature of the disruption, slowing response.	Dual-mode; normal governance applies under ordinary conditions, with decision authority shifting toward operational expertise during confirmed disruption.
Theoretical Foundation	Grounded primarily in decision theory and actuarial risk science; assumes risks are knowable, enumerable, and statistically tractable.	Integrates Complexity Theory, Resilience Engineering, HRO Theory, and Dynamic Capabilities Theory to address conditions where conventional assumptions break down.
Organisational Learning Capability	Post-project reviews are inconsistent, under-resourced, and weakly connected to subsequent planning; learning does not systematically accumulate.	Learning institutionalised as a core capability through the Learning and Adaptation Layer, with each disruption cycle strengthening the sensing capacity of the next.

The most important novelty is not any individual element of the framework but the integration. Resilience Engineering has argued for adaptive capacity over predictive control for decades. HRO Theory has documented what mindful organizing looks like in practice. Dynamic Capabilities Theory has provided the temporal logic of sensing, seizing, and reconfiguring. Complexity Theory has explained why emergent, nonlinear environments produce outcomes that defeat conventional planning. What DARM contributes is the architecture through which these four traditions can be operationalized together in a project risk management context, creating a capability that none of them, on their own, provides.

5. DISCUSSION

5.1 Theoretical Contribution: Building on Four Traditions

The DARM framework contributes to the project management and risk management literatures by synthesizing four bodies of theoretical work that have not previously been integrated in this form for project-level application. Each tradition addresses a genuine dimension of the Black Swan problem. Complexity Theory explains why the problem exists: complex, tightly coupled project environments are structurally prone to emergent, hard-to-anticipate disruptions. Resilience Engineering explains what kind of response is needed: not better prediction but stronger adaptive capacity. HRO Theory explains what that adaptive capacity looks like in organizational practice: specific habits of collective attention, decentralized expertise, and continuous operational awareness. Dynamic Capabilities Theory explains the temporal logic through which adaptive capacity is built and sustained: sensing, seizing, and reconfiguring as a continuous cycle rather than a one-time exercise.

By bringing these four traditions together into a single, operationally specified framework, DARM makes a contribution that extends beyond any of its source literatures. It extends Teece's (2007) sense-seize-reconfigure logic from corporate strategy to project risk management. It grounds the sensing and learning components in the specific organizational practices Weick and Sutcliffe (2015) found most strongly associated with high-reliability performance. And it responds to the calls by Loch et al. (2006), Ramasesh and Browning (2014), and Pich et al. (2002) for operational approaches that go beyond the known-risk paradigm without abandoning analytical rigour.

5.2 Relationship to ISO 31000 and PMBOK-Based Approaches

DARM is not proposed as a replacement for ISO 31000 or the PMBOK risk management processes. Those frameworks address real problems well, and organizations that apply them rigorously are better prepared for the large category of foreseeable and statistically tractable risks that make up the majority of most project risk portfolios. DARM is designed to operate alongside those frameworks as a complementary capability focused on the residual category of risk they are structurally ill-equipped to address. The Risk Sensing Layer of DARM serves as an early-warning supplement to conventional risk identification, widening the perceptual horizon without replacing the structured analytical work that conventional frameworks do well. The two approaches address different regions of the uncertainty landscape and together provide more comprehensive coverage than either provides alone.

5.3 Practical Implications: An Implementation Roadmap

For organizations seeking to build Black Swan resilience through DARM, five implementation steps provide a practical starting point. The first step is building sensing capability. This means investing in environmental scanning systems, stakeholder intelligence networks, and horizon-monitoring tools that extend well beyond the boundaries of the project team itself. Supplier networks, regulatory contacts, adjacent industry communities, and emerging technology monitoring all represent sources of early signal that conventional risk management rarely taps systematically.

The second step is conducting adaptive assessments. Once sensing infrastructure is in place, organizations need to develop the analytical habits to make sense of what it surfaces. This means training project teams in scenario planning and causal mapping, and creating a norm of structured uncertainty reasoning that does not force ambiguous signals into false probabilistic structures before they are ready.

The third step is activating responsive governance. Organization's need to design dual-mode governance arrangements in advance, so that the shift from normal to crisis decision-making can happen quickly and without confusion when it is needed. This requires both structural design work and explicit senior leadership commitment to the principle that authority should migrate toward operational expertise during confirmed disruption events.

The fourth step is capturing organizational learning. After-action review processes need to be treated as a genuine investment rather than an administrative afterthought. Dedicated resources, sufficient time, and a direct connection to the planning frameworks of subsequent projects are the minimum requirements. The fifth step is continuously updating risk sensing, closing the loop and ensuring that learning from each disruption cycle is fed back into the sensing layer, progressively expanding the range of signals the organization is prepared to notice and act upon.

5.4 Directions for Empirical Research

As a conceptual contribution, this paper does not present empirical evidence for the DARM framework's effectiveness. Several lines of empirical research are needed. Case study research examining how organizations with strong track records of navigating major unexpected disruptions actually behave would allow the practices embedded in DARM to be tested against real organizational experience. The megaproject literature (Flyvbjerg *et al.,* 2003; Budzier and Flyvbjerg, 2011) provides a natural starting point.

Survey-based research could examine the relationship between organisational maturity on the five foundational enablers and measured project resilience outcomes. Longitudinal studies tracking organizations as they implement DARM-aligned practices would provide the strongest test of the framework's core claim: that resilience capability compounds across disruption cycles through the Learning and Adaptation Layer. Cross-sector comparisons examining how the framework's applicability varies across infrastructure, technology, healthcare, and defense contexts would refine its boundary conditions. Future research might also develop a DARM maturity model, providing organizations with a structured diagnostic tool for assessing where they currently sit on each dimension of the framework and identifying the most impactful areas for development.

6. Limitations

Several limitations should be acknowledged honestly. The most significant is that DARM remains a conceptual framework without empirical validation. Its theoretical foundations are well-established, but whether the specific architectural choices embedded in the framework produce the resilience outcomes they are designed to produce in real project organizations remains to be demonstrated through the research agenda outlined in Section 5.4.

A second limitation concerns implementation costs. The framework calls for continuous environmental scanning, real-time analytics infrastructure, scenario-based assessment processes, and post-disruption learning systems. These are not trivial investments. Large, well-resourced organizations will find the framework more immediately accessible than smaller organizations with limited analytical capacity. Future work should explore how the framework's core principles can be adapted for resource-constrained contexts.

Third, there is a genuine conceptual ambiguity at the boundary of the Black Swan concept. Taleb's (2007) definition is strict: a true Black Swan is genuinely unforeseeable in advance. In practice, the line between the truly unforeseeable and the merely poorly anticipated is often unclear. Organization’s applying DARM will need to exercise professional judgement in calibrating how much of the framework's adaptive machinery to deploy for any given emerging risk, rather than applying it mechanically. This ambiguity is not a reason to avoid the framework, but it does mean that its application will always require experienced human judgement alongside the analytical tools it provides.

7. CONCLUSION

The argument this paper has made is straightforward, though its implications are significant. Conventional project risk management is a capable tool for managing the risks it was designed to manage. For Black Swan events and emerging risks in complex project environments, it is not adequate, and the reason is structural rather than a matter of insufficient effort. The frameworks, analytical methods, and governance processes that characterize conventional risk management are built on assumptions about the nature of uncertainty that do not hold for the category of risk this paper examines.

The DARM framework proposed here represents an attempt to provide something genuinely different. By integrating Complexity Theory, Resilience Engineering, High-Reliability Organization Theory, and Dynamic Capabilities Theory into a single, operationally specified model, DARM offers an approach that is better suited to the actual conditions that complex projects now face. Its value lies not in any ability to predict Black Swan events, which is impossible by definition, but in its ability to build the organisational capacity to sense emerging threats earlier, reason about uncertainty more honestly, respond more quickly and flexibly when disruptions arrive, and grow stronger from every disruption survived.

The shift that DARM represents is ultimately a shift in how project organizations understand their relationship to uncertainty. Conventional risk management treats uncertainty as a planning problem: something to be mapped, quantified, and mitigated before the project begins. DARM treats it as an operational reality: something that must be continuously sensed, interpreted, and responded to throughout the life of the project. That shift, from static prediction toward continuous organisational resilience and adaptation, is what the project environments of the coming decades will increasingly require. Building the capability to make that shift is difficult, sustained, leadership-intensive work. But for organizations operating in genuinely complex and high-stakes project environments, it is the work that matters most.

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