Operational Readiness and Outcome Assurance: Capabilities for Adaptation, Risk Management and Decision-Making in Asset-Intensive Industries[1]

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1. Introduction

The transition of projects to live operations is one of the most critical phases in the lifecycle of an asset. Large capital projects, whether in energy, infrastructure, transportation, mining, manufacturing, data centers, etc. are typically managed through project management methodologies focused on delivering within cost, schedule, and scope - known as the “iron triangle”. However, even organizations that successfully at delivering against these metrics face significant challenges when transitioning completed projects and try to materialize value through efficient start ups & safe, sustainable and reliable operations.

The gap between project completion and operational performance brings important challenges, recurrently evidenced in multiple transitional and operational variables that include delayed start-ups, erratic production ramp-ups, safety incidents, and costly post-startup interventions among others. The emergence if these variables indicate that technical completeness does not necessarily equate to preparedness to operate new assets. Instead, transitions of live assets to operations are strongly dependent on the orchestration of a larger socio-technical system that includes organizational capabilities, people readiness, procedures, governance, decision-making frameworks, and system integration.

One of the most significant sources of these challenges lays on divergences in the strategic orientation between project management and operations. On the one hand, traditional project management approaches tend to treat the end of construction or commissioning as the conclusion of the project lifecycle. On the other hand, from an operational standpoint, the most critical phase often begins precisely at that moment: bringing an asset to life represents a period characterized by uncertainty, evolving system

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conditions, and the need for rapid decision-making with incomplete information. At the most fundamental level, technical assets, humans and organizational processes interact in ways that are frequently non-linear and difficult to predict.

With the advancement of technology, digital solutions have progressively emerged in the market to support commissioning management, asset performance monitoring, predictive maintenance, project controls, and operational analytics among others. However, in multiple cases, evidence shows that the adoption of these solutions occurs without a diligent alignment with the organizational architectures and processes. This has created a new set of challenges as organizations are attempting to address capability-based challenges through technology. In reality, workflow and data can be automated, yet these cannot replace the organizational capabilities required to manage the complexities in transitioning projects to operations.

Bringing a project to life is surrounded by critical parameters that include uncertainty, incomplete information, and evolving system conditions. This indicates the pivotal role risk management plays during the transition of projects to operations. Ensuring readiness to operate requires a systematic identification, evaluation, and mitigation of multiple risks associated not only with the technical characteristics of the asset, but also with human factors, systems, integration, technology, operational processes and the organization. Risk management is therefore the most critical activity during transition as it is the central mechanism through which organizations anticipate emerging challenges and maintain control over complex operational systems.

By analyzing projects through the lens of complexity theory, we can appreciate their behavior as complex adaptive systems where actions at local level derive global outcomes through the interactions of multiple agents and subsystems. In these systems, risks propagate through interconnected networks of technological, organizational, and human elements. Managing these risks requires a set of capabilities that enable organizations to monitor system interactions, respond to emerging signals, and adapt decision-making processes dynamically.

At the same time, Dynamic Capabilities has emerged as an important body of research in strategic management in the last decades. As a theoretical framework, Dynamic Capabilities is the ability of an organization to sense changes in their business environments, seize opportunities and transform internal resources in response to evolving conditions (Teece, 2007). This stream of research is highly relevant to operational contexts where new projects, assets and operational teams must be integrated to the organization and decisions must be made under uncertainty and incomplete information.

With this in mind, Operational Readiness is presented in this paper as a Dynamic Capability that enables organizations to transition projects to operations in a reliable manner to ensure operational performance. Instead of being treated as a project phase, founded in checklists and supported by digital solutions, Operational Readiness should be understood as a higher order capability that coordinates and orchestrates resources, integrates risks and aligns stakeholders to support adaptation and decision-making during critical transitions.

To achieve this proposition, we draw insights from the intersection of three bodies of research: Dynamic Capabilities, from Strategic Management; Complex Adaptive Systems, from Complexity Theory and Decision-Making under uncertainty from Decision Sciences. The intersection of this knowledge allowed to construct a conceptual framework, referred to as the Three Orders of Operational Capability, formed by operational execution capabilities, operational readiness capabilities and outcome assurance capabilities

Additionally, by considering risk management as a core function that enables organizations to navigate uncertainty and complexity, the proposed framework allows to conceptualize dynamic capabilities as a set of risk-informed decision-making processes, providing a comprehensive perspective on how organizations can successfully manage the critical transition from project completion to stable and reliable operations in a safe, sustainable and reliable manner.

2. Literature Review

To construct the theoretical foundations of the Three Orders of Capabilities framework, this section analyzes three bodies of relevant literature:

- Dynamic capabilities Theory
- Complexity Sciences and Complex Adaptive Systems
- Decision-making under uncertainty and Risk Management

The analysis of these research streams will help explaining why operational transitions are inherently challenging and why organizations must develop capabilities that go beyond traditional project management and adoption of technologies.

Dynamic Capabilities Theory

The Theory of Dynamic Capabilities represented a significant leap in the field of Strategic management. This theory shifted strategy research away from the traditional, static resource-based view of the firm by redirecting it towards the study of organizational

processes to adapt and transform their competences to build and sustain strategic advantage in modern, rapidly changing business environments. Originated by Teece, Pisano, and Shuen (1997), Dynamic Capabilities are "the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments." Eisenhardt and Martin (2000) identified specific organizational processes (such as strategic decision-making, product development and resource allocation) as dynamic capabilities. It is possible to infer that the effectiveness of these processes is heavily dependent on the context and circumstances in which they are applied.

Following this vein of research, strategic management scholars established clear distinction between dynamic capabilities and operational capabilities. Operational capabilities are oriented to enable organizations to perform routine activities in an efficient manner. Dynamic Capabilities, on the other hand, govern how organizations adjust and reconfigure their routines when facing changes (Winter, 2003). This laid the conceptual basis to identify the three core micro foundations of Dynamic Capabilities: Sensing opportunities and threats, Seizing opportunities through resources allocation and Transforming organizational assets and processes to sustain competitiveness (Teece, 2007)

The processes embedded in the Sense-Seize-Transform micro-foundations triad enable organizations to adapt and reconfigure their processes and structures to respond to uncertainty. Important observations were drawn by Helfat and Peteraf (2009) who, by introducing the concept of capabilities lifecycles, emphasized that capabilities are not static. Instead, they evolve over time through stages development, maturity and transformation. This evolutionary view suggests that organizations must adapt with time their capabilities if they want to remain effective in dynamic business environments.

When observing capital projects through the Dynamic Capabilities' lens, it is possible to appreciate the variables involved in the transition from project delivery to operations. Startup environments bring complexities that manifest in multiple forms including the technical complexities of the physical asset, socio-technical interfaces, evolving operational processes and procedures among others. Managing these transitions require organizations to have robust mechanisms to sense emerging operational risks, allocate and timely deploy resources to address them and permanently adapt operational processes.

With the above examination of the literature, it is possible to conceptualize Operational Readiness as a Dynamic Capability that orchestrates operational capabilities in periods of uncertainty. Operational readiness entails strategies that go beyond simply preparing physical assets for start-up: It involves committing and aligning organizational structures,

procedures, workforce capabilities and effectively managing risks to ensure reliable and sustainable operations. It elevates Operational Readiness from a procedural / compliance-driven checklist towards an organizational capability to manage complex transitions.

Complexity Sciences and Complex Adaptive Systems

Managing operational transitions brings important challenges that require a clear understanding of how adaptation occurs as information and interactions evolve. Organizations, as social systems, are permanently facing constraints from both internal processes and business environments, framed by the constant flow of information, interactions and behaviors of agents, and the non-linear relationship between resources and products (Tain, 2021). For this reason, and in addition to the Dynamic Capabilities perspective presented in the previous section, it is suitable to integrate relevant insights in Complexity sciences to gain a better understanding of transitional processes in organizations.

Complexity theory is rooted on the intersection of research in multiple fields, including biology, physics and systems dynamics. Within Complexity theory, the study of Complex Adaptive Systems is relevant to understand organizations in modern business environments. Fundamentally, organizations are social systems comprised by interacting agents whose behavior evolve over time (Holland, 1992), and display specific characteristics such as:

- Emergent behaviors
- Self-organization
- Feedback loops
- Non-linear interactions
- Adaptation to changing conditions and environments

These properties make difficult to analyze the behavior and future state of a system with traditional linear models that assume predictable behaviors. In reality, outcomes are the result of the non-linear interactions among multiple systems components. Organizations operating in large-scale industrial systems are subject to multiple interactions between different entities and functions, including human operators, management systems, supply chains and inter-departmental functions among others. Issues extend beyond isolated technical deficiencies as they originate from interactions across socio-technical systems. In this vein, Stacey (1996) highlights the importance of implementing complex responsive processes that enable adaptive coordination, distributed decision-making and continuous learning.

Complexity significantly increases in transitional phases: During asset start-up, systems are brough to life progressively and will evolve from a static state (in relatively "controlled environments") to perform in a dynamic, real life operational conditions. Operational challenges, along with schedule delays and cost overruns, emerge from the interplay between technical, organizational and institutional variables Flyvbjerg (2014). Operational transitions, therefore, will require organizational capabilities to manage systems interactions and progressively identify risks. Considering this, Operational Readiness then should be understood as a capability to navigate complexity and anticipate emerging issues in projects and organizations.

Decision-Making Under Uncertainty and Risk Management

A third stream of knowledge relevant to operational readiness concerns decision-making under uncertainty and the management of risks.

One of the most prominent advancements in decision theory was achieved by challenging the assumptions of perfect rationality, with the seminal contribution from Simon (1957) that created the concept of bounded rationality. Bounded rationality argues that cognitive limitations and incomplete information drive individuals to make decisions using simplified mental models of reality that adjust to their perceptions off the world and belief systems.

Another pivotal work on decision-making research was prospect theory (Kahneman & Tversky, 1979). This theoretical framework expanded Simon's bounded rationality by demonstrating that individuals calculate outcomes and risks in ways that deviate from rational models. For instance, time pressures, incomplete data and evolving systems conditions strongly influence the variables for decision-making.

More recent research studied how experts make decisions in real-world conditions, characterized by high uncertainty and high stake. The findings show that experts rely more on situational awareness and pattern recognition than in analytical reasoning when making decisions (Klein, 1998). These contemporary works opened a new body of research known as naturalistic decision-making, highly relevant to operational environments. Naturalistic decision Making, or NDM) "is concerned with how people decide and behave in complex, dynamic and uncertain environments, in which decisions have significant consequences" (Gore et al., 2023). In these environments, decision-makers must respond on a timely fashion, thus it makes an imperative for organizations to have in place processes and structures that support effective risk-informed decision-making.

This imperative has been recognized across all industries. For instance, global standards, like ISO 31000, strongly emphasize the importance of integrating risk management and

organizational decision-making processes. As mentioned in previous sections, risks tend to propagate across the interconnectedness of technical and organizational systems.

The insights of this short review allow to propose that Risk Management is a key foundation of Operational Readiness as it enables organizations to identify, assess and develop responses to threats before issues arise, adapting accordingly especially in transitional stages where value can rapidly erode.

3. The Three Orders of Operational Capability Framework

From the literature review, we can distill the following insights relevant to the transition of projects to operations:

- Organizations must develop and deploy dynamic capabilities to be able to adapt and reconfigure operational systems in response to changes.
- Organizations behave as complex adaptive systems, where outcomes result from interactions among technical systems, human actors, and corporate processes.
- Effective management of these systems requires risk-informed decision-making processes capable of effectively function while navigating uncertainty.

Building on these insights, this paper proposes a conceptual framework, referred to as "the Three Orders of Operational Capability", describing capabilities as a system of three strategic layers that work in an interconnected way to induce effectiveness and success in operational transitions. Each layer performs a distinct function within a broader operational system that foster adaptation and control. The three orders of Operational Capabilities are:

- First Order Capability: Operational Execution
- Second Order Capability: Operational Readiness
- Third Order Capability: Outcome Assurance Capability

First-Order Capability: Operational Execution

The first layer corresponds to what may be known as operational execution capability. Building on Winter (2003) who defined ordinary capabilities, we define Operational Execution capabilities as those that enable organizations to perform routine tasks and maintain operations under normal conditions in a safe and reliable manner. Some examples of these capabilities in industrial environments include standard operating procedures (SOPs), equipment operation and maintenance, production planning and scheduling, asset performance monitoring, safety management systems, training and competency, among others.

Operational Execution capabilities are essential for the ongoing functioning of operational assets. However, they are not sufficient alone to ensure successful startup and transition of assets to operations since these capabilities are built on stable operating conditions rather than dynamic transitions between project and operational environments. Indeed, as we will see in the case studies section, evidence shows that when organizations rely solely on operational execution capabilities, they tend to struggle during transitional stages where there's a need to respond to emergent variables when systems conditions evolve and operations have not reached a stable state.

Second-Order Capability: Operational Readiness

The second layer of capability corresponds to operational readiness. Essentially, Operational Readiness can be understood as a dynamic organizational capability oriented to the successful start-up of and transition of an asset to operations and the subsequent sustainment of its performance, in safe, sustainable and reliable manner (Tain, 2025). Rather than concentrating on routine operations in operational execution, Operational Readiness focuses on preparing the organization to receive and operate the asset in an effective manner with a clear view of the risks and future scenarios.

This capability enables the organization to orchestrate operational teams, technical systems, governance and risk management processes. Some of the typical Operational Readiness capabilities include activities such as readiness assessments and gap analysis, active development and rationalization of operational procedures, integration of maintenance systems and asset management strategies, training and strategic workforce acquisition, proactive identification and mitigation of operational risks among others.

Operational Readiness fits in the Dynamic Capabilities framework as it performs functions that are in line with the three micro foundations identified by Tece (2007):

- **Sensing**: Identification of operational risks and readiness gaps before bringing the project to life
- **Seizing**: allocating resources and implementing organizational structures to address those gaps.
- **Transforming**: adjusting operational processes and governance structures to support reliable operations.

Operational readiness, therefore, serves as the bridge to cross the transition between project completion and operational execution, ensuring that organizations, as socio-technical system, are effectively prepared to function once the asset begins operating. More importantly, operational readiness is the primary mechanism to integrate risk

management into operational transitions, leading the way to systematically identify and mitigate them prior to startup.

Third-Order Capability: Outcome Assurance

The third layer represents what can be referred to as Outcome Assurance. At this third order, the focus is on ensuring that operational systems continue to perform in a sustainable and reliable manner while navigating uncertainty and complexity.

The roots of this capability lay on adaptive governance, proactive monitoring and organizational mechanisms to respond to emergent condition in a timely manner. In practice, this materializes in key strategic organizational mechanisms such as decision governance, continuous learning and feedback, performance monitoring and operational resiliency mechanisms.

Operational conditions can change rapidly due to factors such as equipment behavior, supply chain disruptions, human factors or regulatory shifts. Outcome Assurance allow organizations to detect these changes and adjust their operational strategies to sustain reliable performance over time.

By observing Outcome Assurance from the Dynamic Capabilities point of view, it is possible to conceptualize it as an advanced form of the Transforming capability that enables organizations to adequately respond to emerging conditions and adapt accordingly. Figure 1 below depicts the conceptual model of the Three Orders of Capabilities framework

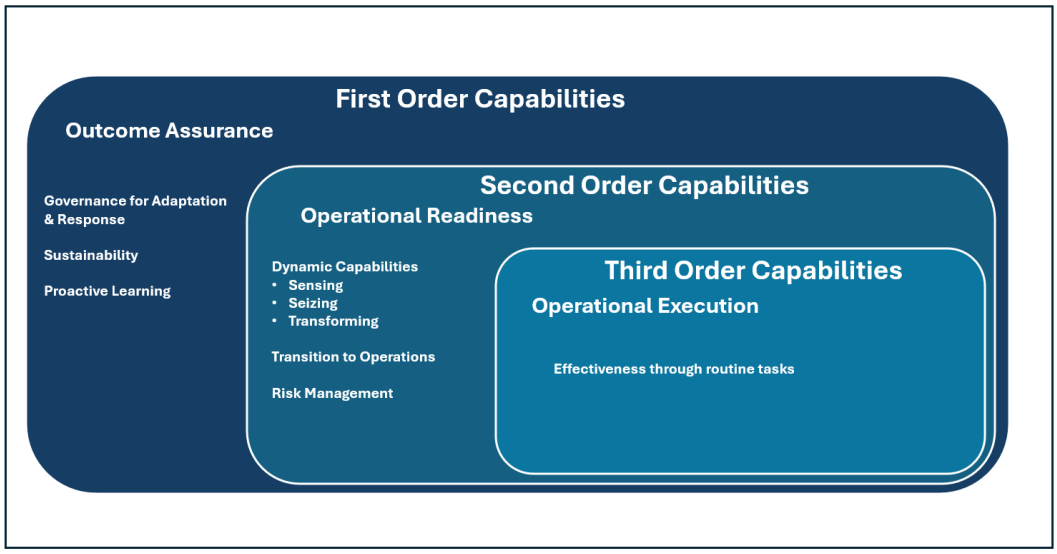

Fig 1: The Three Orders of Capabilities Framework

Capability Interactions in Complex Systems

Operational execution capabilities enable organizations conduct day-to-day operations; Operational Readiness capabilities enable organizations to effectively transition into operational states and Outcome Assurance capabilities ensure reliability of operational performance over time. These three orders of operational capabilities should be viewed as a set of interconnected layers of a larger socio-technical complex adaptive system with dynamic and interdependent interactions among them.

The interconnectedness between layers causes that risks and weaknesses to propagate through the system causing instability. For instance, insufficient or inadequate operational readiness efforts may result in delays and/or equipment failures. Weak outcome assurance mechanisms may amplify small operational disturbances to escalate into major disruptions, difficult to predict.

Risk management has a pivotal role across the layers of these capabilities: Risk management allows organizations to identify and address threats prior to engaging in start-up activities during readiness phases. Similarly, during operational phases, risk monitoring and control mechanisms enable organizations to effectively identify and respond to threats and avoid ripple effects across the system. All this indicates that, rather than a standalone process, risk management can be viewed as a cross-cutting capability embedded in the overall operational system.

Key Implications of the Framework

The Three Orders of Operational Capability framework has the following important implications for organizations managing complex assets:

First, it distinguishes operational execution capabilities from Operational Readiness capabilities, frequently combined in practice. Often, organizations assume that operational expertise by itself is enough to successfully bring projects to life. Although necessary, it is not sufficient to address the emerging complexities naturally emerged in transitional stages: without well-defined and structured readiness capabilities, operational teams may face significant challenges when transitioning from project environments to operational systems.

Second, it emphasizes the importance of developing organizational capabilities rather than relying solely on technological solutions. Digital platforms and operational software can support readiness activities, yet they cannot substitute governance structures, risk

management processes, and decision-making frameworks required to manage complex transitions.

Finally, the framework highlights the strategic importance of risk-informed decision-making in operational environments. Risk management processes embedded with readiness and Outcome Assurance capabilities enable organizations to enhance their ability to anticipate threats and effectively respond to emerging challenges.

The above implications suggest that, besides focusing on project delivery, organizations must develop high-order capabilities to improve predictability and reliability of start-ups, ensuring an effective transition of assets to operations

4. Risk Management as a Foundation of Operational Readiness

The transition from project completion to operations is one of the most risk-intensive phases in the lifecycle of industrial assets:

- From an asset point of view: projects designed and constructed under controlled conditions suddenly pass to real-life, operational conditions. This creates dynamic and often unpredictable environments.
- From an organizational point of view: structures shift from project governance to operational management. Procedures are executed for the first time under real conditions, and decision-makers must respond to emerging technical and operational challenges.

For this reason, risk management becomes a central mechanism for organizations to anticipate uncertainty and maintain operational control. Risk management should therefore be viewed as a foundation of operational readiness that enables organizations to navigate the complexities inherent to system transitions.

Risk in Operational Transitions

Starting up an asset creates multiple sources of uncertainty. Systems may show behaviors that were not fully observed during commissioning or testing, and operational teams may face challenges may they need to respond to situations that differ from those envisioned during project planning. Some of these challenges may materialize in unanticipated risks such as equipment failures, inadequate or incomplete operational procedures, gaps in competence and interface breakdowns between project execution and operational teams.

Additionally, during start-up and transitional phases, the potential for risks to emerge simultaneously and aggregate increases. This creates mutually reinforcing conditions that propagate and amplify across interconnected systems, leading to cascading effects that will ultimately affect operations. In complex socio-technical systems, failures often arise from interactions among multiple factors rather than a single identifiable cause (Perrow, 1984) and are particularly exacerbated when these systems are not at a fully stable state. By systematically evaluating operational gaps and potential failure modes, operational readiness frameworks provide organizations with structured mechanisms to timely identify risks and reduce the likelihood of anomalies during operational phases.

Risk Management and Dynamic Capabilities

Risk management has a direct incidence to the processes that build the micro foundations of the Dynamic Capabilities framework (i.e. sense, seize and transform the organization) in response to environmental changes (Teece, 2007):

- Organizations can sense emerging threats and potential operational vulnerabilities before they materialize though risk identification activities focused on operational transitions. Some of these activities include structured risk assessments, readiness reviews and hazard analyses among others.

- Risk mitigation planning activities enable organizations to seize opportunities to improve system resilience and strengthen operational preparedness. Some typical mitigation strategies include additional testing, procedural adjustments, workforce training, or contingency planning.

- Risk monitoring and response mechanisms support the timely transformation of operational systems. As operational information becomes available, organizations can adjust procedures, reallocate resources, and refine operational strategies to address emerging conditions.

Risk management, therefore, is not just a protective mechanism to the organization. It is a capability that supports adaptation in complex environments.

Risk Governance and Decision-Making

Robust decision-making processes are pivotal to respond to risks during start-up and transitional stages of the assets to operation. This obeys to the fact that start-up environments are often surrounded by circumstances with significant potential to impact outcomes, including the rapid evolution of systems conditions, uncertainty, time pressures and competing constraints in the project and the organization. Under these

circumstances, decision-makers effectively balance safety, operational performance and commercial objectives among other strategic variables in the project while adequately responding to emergent situations.

In recent years, research in decision-making shows that individuals normally develop mental models based on individual experiences, or heuristics, which frame judgments for decision-making in the presence of uncertainty (Kahneman and Tversky, 1979; Klein, 1998). While expert judgement is valuable, organizations must develop and deploy governance mechanisms that ensure risks are correctly identified, categorized and prioritized to ensure the most adequate response strategies at the right time.

Operational Readiness, as a capability, provides mechanisms to address these challenges through structured governance processes such as readiness assessments, progressive data analysis, cross-functional orchestration, operation-driven risk management and escalation protocols among others. This ensures integration of technical expertise with management oversight with an outcome-assurance perspective and the timely response of risks before they become operational failures.

Risk Management Across the Three Orders of Capability

Risk management is a function that supports operational performance by operating across the layers of the Three Orders of Operational Capability framework:

- At the operational execution layer, risk management focuses on routine operational hazards such as equipment failures, safety risks, and operational disruptions.

- At the operational readiness layer, the focus is on identifying and mitigating risks associated with start-up and transition to operations. This includes readiness gaps analyses, validation of operational procedures, and the preparation of operational teams to manage startup ad receive the live asset.

- At the Outcome Assurance layer, risk management is oriented to the continuous monitoring and adequate adaptation of operational systems. This orientation ensures the timely detection of variances and operational irregularities, allowing the organization to respond before small anomalies escalate into major issues.

As noted in previous sections, due to the dynamic interaction of these layers, weaknesses in risk management processes at one level propagate to other levels. For instance, deficiencies in identification risks during project phases may compromise the readiness and derive operational challenges during startup and the reliability to sustain operations.

Therefore, organizations must ensure strong readiness risk management processes for the successful transition to operations and the resilience of the live asset.

Limitations of Technology-Driven Risk Solutions

With the advancement of technology, organizations have increasingly adopted digital platforms to support risk management activities and operational analytics. Especially with the incorporation of AI into the digital landscape, these tools vary in sophistication and provide valuable capabilities such as predictive maintenance analytics, real-time monitoring and enhanced automatic reporting among others. However, technological solutions alone cannot replace the underlying organizational capabilities required to manage operational risks effectively.

Without clearly defined risk governance structures, operational procedures, and decision-making frameworks, the inadequate adoption of digital tools brings the potential to generate large volumes of data without improving the organization's ability to interpret and respond to operational signals on time or, even worse, not distinguish noise from a real threat. This makes organizations vulnerable as they create a false sense of security based on technology, subordinating operational preparedness to software outputs not driven by Outcome Assurance. Digital tools should support and facilitate the organization's ability to manage and respond to risks. They should never be a substitute for organizational risk management capabilities.

Risk Management as a Strategic Capability

The above sections allow to propose that risk management becomes more than a simple response mechanism when it is integrated into operational readiness. Fundamentally, risk management is a strategic capability that allows organizations to anticipate challenges in transitional stages. It identifies the parameters for resource allocation and orchestration to successfully navigate the uncertainty that surrounds the complexities associated to the start up of and transfer of systems and assets to operations. Simply put, risk management is a key foundation of operational readiness.

5. Case Evidence: Operational Transition Failures in Complex Systems

Case 1: The Heathrow Terminal 5 Opening Crisis

The Heathrow Terminal 5 Opening Crisis is a notable example of the differences between completeness and readiness and how deficiencies in operational readiness programs can result in significantly erosion of the value of a capital project.

As described by UK House of Commons Transport Committee (2008), the Terminal 5 terminal was executed on time, successfully completing the scope and meeting its engineering and construction objectives. However, the transition into live operations exposed critical gaps in preparedness: On opening day, systems that performed well in isolated testing failed under real operating conditions. Specifically, the automated baggage handling system collapsed resulting on thousands of misplaced bags and extensive flight disruptions. Scenario-based testing exercises, considering the whole system, proved to be insufficient, with limited simulation of peak loads or failure conditions.

In parallel to the technical issues, the people readiness side also showed significant deficiencies as the workforce was not adequately prepared: Many staff didn't have the proper training on the new systems, while others could not access restricted areas due to unresolved clearance issues.

The Heathrow terminal 5 revealed a fundamental disconnect between infrastructure completion and operational capability, with a systemic failure that involved the technical and the personnel side of the transition to sustainable operations. In a nutshell, the organization was not prepared to respond when new variables and issues emerged.

The crisis was further exacerbated by the poor coordination between British Airways stakeholders. All this demonstrated how issues can rapidly propagate through the capabilities layers, and without integrated readiness across people, processes, and systems, even the most sophisticated facilities cannot deliver reliable outcomes.

Case 2: The Texas Winter Storm

The FERC Report (FERC, 2021) illustrates how deficiencies in operational readiness triggered systemic failure in critical infrastructure during the Texas Winter Storm Power Crisis.

The energy system in Texas was designed for efficiency and normal operating conditions, yet it lacked preparedness for extreme, but foreseeable, weather events: A significant drop in temperature caused the simultaneous failure of multiple energy generation sources, including natural gas, wind, and coal, due to inadequate winterization. As a result, equipment froze, fuel supply chains were disrupted, and power plants were forced offline.

The crisis revealed a deeper issue beyond technical failure of the asset: the lack of integrated readiness across interconnected system was evidenced in natural gas shortages that limited electricity generation while power outages disabled gas

compression and distribution. This created a cascade effect that propagated across the energy value chain.

Following earlier cold events, scenario planning exercises were conducted. However, they were not translated into tangible, enforceable measures. ERCOT did not mandate resilience standards, and market incentives discouraged investment in redundancy, showing deficiencies in governance structures further amplified the crisis.

Texas Winter Storm Power Crisis is a clear demonstration that infrastructure completeness and operational efficiency are insufficient without resilience-focused readiness. Robust operational programs guarantee alignment in assets, systems, governance, and risk management to ensure reliable performance under both normal and extreme conditions.

Case 3: Deepwater Horizon

Our third example, the Deepwater Horizon disaster in 2010, illustrates the importance of operational readiness and risk governance in complex industrial systems.

The explosion of the offshore drilling rig in the Gulf of Mexico resulted from a combination of technical failures, flawed decision-making, and inadequate risk management processes. Investigations conducted by the U.S. National Commission on the BP Deepwater Horizon Oil Spill identified multiple contributing factors that include deficiencies in safety culture, operational oversight, and risk management practices (National Commission on the BP Deepwater Horizon Oil Spill, 2011).

Time pressures influenced decision-making in the operations team increasing the levels of risk tolerance. This was strongly evidenced in the underestimation of warning signals related to well integrity. As a result, the response to the emerging events that followed was inadequate, leading to a disaster that claimed 11 lives and severe financial, environmental and reputational consequences.

Deepwater Horizon is a clear testimony of how the lack of robust governance structures, capable to integrate expertise, risk management and decision-making, makes organizations and assets vulnerable to threats, significantly increasing the potential to severe consequences when unanticipated situations emerge. All this reinforces the imperative of developing and deploying strong organizational capabilities to effectively manage and respond to operational risks within complex systems.

6. Strategic Implications

The analysis presented in this paper allows to distill the following implications for operational transitions and the strategic significance of the Three Orders of Operational Capability framework:

Recognizing Operational Readiness as a Strategic Capability

One of the most important implications in this paper is the need for organizations to reframe operational readiness as an outcome-driven strategic organizational capability, rather than a procedural, completion-oriented milestone within project management.

In many organizations, readiness activities are treated as administrative tasks that occur near the end of project execution. These activities often are reduced to checklists intended to validate that procedures, documentation, and personnel are in place prior to startup. Although these activities are valuable, they alone are insufficient to address the dynamic interactions involved in complex transitions, emerged from multiple entities and processes, such as technical systems, operational teams, supply chains and decision-making processes among others.

Successfully managing organizational interactions requires developing capabilities that extend beyond procedural compliance. Operational Readiness, viewed as a Dynamic Capability, provides organizations with structured processes to sense risks associated to start up and operational transitions, commit and mobilize resources to address gaps affecting readiness, and effectively engaging in transformative efforts as conditions evolve.

Integrating Risk Management into Operational Governance

The insights in this paper highlight the importance of incorporating risk management processes directly into operational readiness governance structures. Given the dynamic nature, uncertainty and evolving behavior of systems in start-up environments, organizations must develop robust mechanisms for the early identification and assessment of risks as well as the corresponding mitigations and response strategies before startup occurs.

The foundations of an effective readiness governance lay on structured risk management processes that include strategic mechanisms to enable the organization to integrate technical expertise with management oversight, such as systematic readiness risk assessments, operational risk registers, escalation mechanisms for critical risks and cross-functional readiness reviews. Also, it is essential to have in place mechanisms for

continuous risk monitoring across the organization, especially during early operational phases, to detect emerging situations and avoid their escalation into major events.

Moving Beyond Technology-Centered Solutions

With the advancement technology and competition in modern business environments, organizations have increased their tendency to adopt a wide range of digital solutions designed to improve operational performance. Some of these solutions include commissioning management software, asset performance monitoring systems, predictive maintenance analytics, and operational dashboards. These technologies can significantly improve information visibility and operational coordination, yet some organizations have the expectations that complex challenges can be fully delegated technology. Such expectations can lead to problematic results.

Without a robust alignment and integration with the operations and the attributes of the organization (systems, culture, etc.), the indiscriminate reliance on digital packages can inhibit adaptation, reducing the ability to respond to emerging situations. Technology can support operational processes, but it cannot substitute for the internal strategies required to interpret information, manage risk, and coordinate decision-making across complex systems: these are intrinsic capabilities of the organization. Consequently, organizations should be careful in selecting digital solutions and approach technology adoption as an enabler of operational capabilities rather than a replacement for them.

Integrating Project and Operations

A recurring challenge in projects emerges from tensions between project and operations organizations. These tensions normally originate from the strategic orientation of these agents: On the one hand, project teams are typically scope-oriented, focused on delivering assets within schedule and budget constraints. Operational teams, on the other hand, are system-oriented and responsible for long-term asset performance and reliability. These misalignments create issues during transition from project delivery to operations, with the potential to become real problems during start up, transition of live assets and initial operations.

Operational readiness capabilities provide mechanisms for addressing and bridging these differences by establishing structured collaboration between project and operational stakeholders. Some of these mechanisms include:

- joint readiness governance committees
- integrated project–operations transition teams

- cross-functional readiness assessments
- shared operational performance objectives.
- Pre-startup safety reviews

These mechanisms help ensure that operational requirements are incorporated into decisions along the project lifecycle, ensuring that operational teams are adequately prepared to receive and operate the new assets.

Developing Outcome Assurance Capabilities

Finally, beyond readiness itself, organizations should also develop Outcome Assurance capabilities that govern transitions of operating assets and their performance after startup. Outcome Assurance capabilities focus on actively monitoring operational performance, allowing to detect signals of potential threats early enough to enable rapid organizational responses and enhance resiliency. Some examples of Outcome Assurance strategies include continuous performance monitoring systems, operational learning mechanisms, adaptive governance structures.

Outcome assurance capabilities allow organizations to maintain control over complex operational systems and trigger adaptation when conditions evolve. In this sense, Outcome Assurance represents the highest order of operational capability as they enable organizations to both transition into operations successfully and to sustain reliable performance over time.

7. Conclusion

The transition from projects to operations is one of the most critical phases in the lifecycle of an asset. Traditional project management frameworks normally measure success against the completion of a technical scope under established parameters of cost and schedule. Although necessary, this is not sufficient to guarantee an effective transition to operations and reliable outcomes.

Crossing the threshold from a completed scope to a living asset introduce significant complexities associated to uncertainty, dynamic interactions among system components, and decision environments, characterized by incomplete information, ultimately affecting the potential of the asset to generate value through reliable operational outcomes.

The success and reliability of operational transitions depend not only on the performance of execution and projects completions, but on the capabilities of an organization to navigate complexity and manage uncertainty and operational risks. Drawing from three research streams (Dynamic Capabilities theory, Complexity Sciences and Decision-

Making under uncertainty), it is possible to propose a conceptual framework, referred to as Three Orders of Operational Capability, as a layered system of organizational functions whose basis lay on risk management.

Specifically, these layers are:

- First-order capabilities, or Execution Capabilities, focused on supporting routine operational execution. These capabilities enable organizations to operate assets efficiently under stable conditions.

- Second-order capabilities, described as Operational Readiness capabilities. These are the mechanism that enable organizations to prepare them for transitioning from project environments to operational contexts. These capabilities drive the coordination of technical systems, operational teams, governance structures, and risk management processes to reduce uncertainty during startup phases.

- Third-order capabilities, referred to as Outcome Assurance capabilities. These high-order capabilities provide strategic direction and enable organizations to sustain reliable operational performance with adaptive governance, continuous monitoring, and proactive learning.

The foundations of these capabilities lay on the effective institutionalization of risk management capabilities across all layers. Specifically, this entail strategies and tools that enable the organization to identify, assess, mitigate and respond to start-up and operational risks, adapt decision-making processes and control complex systems interactions. This reinforces the importance of an organization's ability to make risk-informed decisions is a central mechanism to exercise Operational Readiness capabilities.

Another important implication in this paper is the increasing reliance on digital solutions without a proper evaluation of the transition process and the organization itself. Commercial solutions, software platforms and digital packages are progressively appearing in the market, with impressive abilities to analyze, integrate and monitor information. However, technology alone cannot substitute the capabilities of an organization, as a socio-technical system, to manage its complex interactions. For a reliable support in transitional and operational stages, technological tools must be effectively aligned and integrated with the governance structures and organizational attributes that surround risk management and decision-making.

In general, by conceptualizing Operational Readiness as a second-order capability grounded in risk management, it is possible to provide a deeper understanding of how organizations can successfully manage the critical transition from project delivery to reliable operational performance. This Outcome-Assurance oriented framework enables organizations to materialize the value the project was conceived for by providing a strategic orientation to configure and arrange processes and resources. By adopting this approach, it will be possible to better navigate the complexities associated to systems start-up and transition of projects to operations in a safe, reliable and sustainable manner.

References

Eisenhardt, K.M. and Martin, J.A. (2000) 'Dynamic capabilities: what are they?', *Strategic Management Journal*, 21(10–11), pp. 1105–1121.

FERC (2021) *The February 2021 Cold Weather Outages in Texas and the South Central United States* [online]. Available at: https://ferc.gov/media/february-2021-cold-weather-outages-texas-and-south-central-united-states-ferc-nerc-and (accessed: 22-February-2026)

Flyvbjerg, B. (2014) 'What you should know about megaprojects and why: an overview', *Project Management Journal*, 45(2), pp. 6–19.

Gore, J., Shortland, N., Power N. and Brown O. (2023) 'Editorial: Naturalistic decision making (NDM): epistemic expertise in action', *Frontiers in Psychology*, 14:1303098

Helfat, C.E. and Peteraf, M.A. (2009) 'Understanding dynamic capabilities: progress along a developmental path', *Strategic Organization*, 7(1), pp. 91–102.

Holland, J.H. (1992) *Adaptation in Natural and Artificial Systems*. Cambridge, MA: MIT Press.

Kahneman, D. and Tversky, A. (1979) 'Prospect theory: an analysis of decision under risk', *Econometrica*, 47(2), pp. 263–291.

Klein, G. (1998) *Sources of Power: How People Make Decisions*. Cambridge, MA: MIT Press.

National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling (2011) *Deep Water: The Gulf Oil Disaster and the Future of Offshore Drilling*. Washington, DC: U.S. Government Printing Office. Available at: https://www.govinfo.gov/app/details/GPO-OILCOMMISSION

Perrow, C. (1984) *Normal Accidents: Living with High-Risk Technologies*. Princeton: Princeton University Press.

Simon, H.A. (1957) *Administrative Behavior*. New York: Free Press.

Snowden, D.J. and Boone, M.E. (2007) 'A leader's framework for decision making', *Harvard Business Review*, 85(11), pp. 68–76.

Stacey, R.D. (1996) *Complexity and Creativity in Organizations*. San Francisco: Berrett-Koehler.

Tain, D. (2019) Capitalizing on Complexity in Modern Business Environments: A Network-Based Perspective for Projects and Organizations, *Journal of Applied Business and Economics*, 23 (1), pp. 1-2

Tain, D. (2025) Operational Readiness: An Expertise-Based Vol. XIV, Issue V – May 2025 Framework to Bring Projects to Life, *PMWorld Journal*, XIV (V)

Teece, D.J., Pisano, G. and Shuen, A. (1997) 'Dynamic capabilities and strategic management', *Strategic Management Journal*, 18(7), pp. 509–533.

Teece, D.J. (2007) 'Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance', *Strategic Management Journal*, 28(13), pp. 1319–1350.

UK House of Commns Transport Committee (2008) *The Opening of Heathrow Terminal 5* [online]. Available at: https://publications.parliament.uk/pa/cm200708/cmselect/cmtran/543/543.pdf (accessed: February 22 2026)

Winter, S.G. (2003) 'Understanding dynamic capabilities', *Strategic Management Journal*, 24(10), pp. 991–995.

ISO (2018) *ISO 31000: Risk Management – Guidelines*. Geneva: International Organization for Standardization.

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