

Knowledge Management Failures as Latent Safety Risks in Aviation Organizations

Serafeim Tsiakalos
University of the Aegean

Hayat El Asri
Al Akhawayn University

Aviation safety has achieved remarkable performance improvements over recent decades, yet accident investigations continue to reveal organizational vulnerabilities that are not easily explained by technical failure or procedural non-compliance alone. Safety research has long emphasized the role of latent organizational conditions in accident causation, but the contribution of Knowledge Management (KM) to these conditions remains insufficiently examined. This paper addresses this gap by conceptualizing KM failures as a distinct class of latent safety risks in aviation organizations. Drawing on safety science, organizational learning theory, and KM literature, the paper develops a conceptual framework that explains how degraded knowledge processes gradually weaken multiple layers of safety defense. The paper is conceptual and theory-building in nature, offering a mechanism-based account of how KM-related breakdowns operate as upstream, latent conditions in aviation safety. Four interrelated failure modes are identified: fragmentation of safety-relevant knowledge, erosion of tacit expertise, deficient organizational learning loops, and impaired sensemaking. It synthesizes these failure modes into an integrative framework and advances a set of propositions intended to support subsequent empirical testing. These failures tend to accumulate over time, often remaining invisible to conventional safety indicators, while reducing organizational resilience and increasing dependence on individual vigilance. The framework reframes safety as an emergent organizational capability rooted in how knowledge is created, integrated, and interpreted. On this basis, it positions knowledge degradation as a distinct latent safety mechanism and treats KM as a core structural element of aviation safety systems rather than a peripheral managerial activity. The paper translates the framework into propositions to guide empirical research and provides a basis for safety managers and oversight bodies to identify, assess, and govern KM-related latent risk, particularly where operational complexity and data abundance can obscure gradual erosion in learning and sensemaking.

Keywords: transport management, safety governance, aviation safety, knowledge management, latent conditions, organizational learning, safety management systems, high reliability organisations

INTRODUCTION

Aviation is widely regarded as one of the safest modes of transportation, yet this safety record is neither accidental nor purely technological. It is the outcome of complex organizational systems designed to

anticipate, absorb, and learn from failure in environments where the cost of error can be catastrophic. Over several decades, safety research has demonstrated that major aviation accidents rarely result from isolated technical malfunctions or individual errors. Instead, they emerge from latent organizational conditions that accumulate over time until they align to breach system defenses (Reason, 1990; Reason, 1997). Within this body of work, factors such as safety culture, organizational learning, and human factors have received sustained scholarly attention. By contrast, knowledge management (KM), despite being central to how organizations learn, remember, and adapt, remains under-conceptualized as a safety-critical organizational capability in aviation.

Safety-critical aviation organizations depend fundamentally on their ability to generate, interpret, retain, and transfer knowledge across time, functions, and professional communities. This includes explicit knowledge embedded in procedures, manuals, and regulations, as well as tacit knowledge derived from experience, judgment, and shared practice. Effective safety management therefore presupposes not merely the availability of data or documentation, but the existence of organizational mechanisms that enable sensemaking, learning, and institutional memory (Weick, Sutcliffe, & Obstfeld, 2005). When such mechanisms degrade, organizations may remain formally compliant with safety management requirements while progressively losing their capacity to recognize weak signals, challenge assumptions, or learn meaningfully from incidents and near-misses.

The global institutionalization of Safety Management Systems (SMS), consolidated through the International Civil Aviation Organization's (ICAO) Annex 19, has significantly strengthened the procedural and regulatory foundations of aviation safety. At the same time, safety scholarship has increasingly questioned the assumption that the presence of SMS structures automatically produces effective organizational learning and risk control (Dekker, 2014; Leveson, 2011). A recurring concern is that safety systems may drift toward bureaucratized performance, where they focus on data collection, reporting activity, and compliance demonstration while remaining fragile in the way safety knowledge is interpreted, integrated, and translated into adaptive action.

It is worth noting that safety management systems do not consist solely of policies and procedures. They also include the organization's documentation and knowledge systems, along with the processes that use them (Stroeve et al., 2022). This is significant because KM failures can exist within SMS on paper while undermining how safety knowledge is interpreted and applied in everyday work. ICAO's SMS logic is structured around four components: safety policy and objectives, safety risk management, safety assurance, and safety promotion (Stroeve et al., 2022). If knowledge becomes fragmented, outdated, or weakly institutionalized, these components may remain formally complete while the quality of organizational learning degrades in practice.

From an organizational perspective, KM encompasses the processes through which knowledge is created, shared, interpreted, retained, and institutionalized across organizational boundaries (Nonaka, 1994). In complex, high-reliability settings such as aviation, KM is not a peripheral administrative function but a foundational capability that underpins safe performance. The High Reliability Organization theory emphasizes continual learning, sensitivity to operations, and deference to expertise as core principles of sustained safety (Weick & Sutcliffe, 2001). Each of these principles depends implicitly on effective knowledge flows, yet KM is rarely treated explicitly as a structural safety defense. Instead, failures of knowledge are often reframed as communication breakdowns, training deficiencies, or human error, which obscures their systemic origins.

KM failure is analytically distinct from weak safety culture or generic communication breakdown. In a culture problem, individuals may hesitate to report, speak up, or challenge assumptions. In a KM problem, reporting and communication may occur, yet the organisation fails to convert information into shared understanding and consistent practice across sites and functions. A maintenance anomaly, for example, can be recorded and locally corrected, while the underlying learning does not travel because units classify events differently, interpret causes through different frames, or lack a forum to translate local experience into system-level guidance. In this way, culture shapes the willingness to surface signals, whereas KM shapes whether surfaced signals become transferable, durable, and operationally usable knowledge. The

paper develops a framework of four KM failure modes, fragmentation, tacit erosion, learning-loop breakdown, and sensemaking misalignment, and advances propositions for future empirical testing.

A critical insight from safety science is that latent conditions such as degraded knowledge flows, siloed expertise, or eroded institutional memory can persist for long periods without visible consequences (Reason, 1997). In aviation organizations, these conditions may take the form of outdated procedures that are formally maintained but informally bypassed, lessons learned that are documented but not internalized, or safety data that is analyzed without being meaningfully integrated into operational decision-making. Over time, such failures reduce organizational resilience, narrow the margin for recovery, and increase dependence on individual vigilance rather than systemic robustness.

Moreover, the organizational learning theory reinforces the importance of examining KM failures as structural phenomena rather than episodic shortcomings. Argyris and Schon (1978) distinguish between single-loop learning, which focuses on correcting errors within existing assumptions, and double-loop learning, which involves questioning the underlying norms and mental models shaping organizational behavior. Aviation organizations often demonstrate strong single-loop learning through procedural updates and corrective actions, yet struggle with double-loop learning when safety issues implicate deeper organizational assumptions, knowledge hierarchies, or power relations. KM failures play a central role in this dynamic by constraining the organization's capacity to reinterpret risk and adapt its governing assumptions.

Despite the centrality of knowledge to safety, existing aviation research tends to treat KM implicitly, embedded within broader discussions of safety culture, human factors, or information systems. Conversely, the KM literature has largely examined knowledge processes in corporate and innovation-driven contexts, with limited engagement with safety-critical industries where the primary objective is risk containment rather than value creation (Nonaka & Takeuchi, 1995). This fragmentation has produced a conceptual gap: the absence of an integrated framework that explicitly positions KM failures as latent safety risks in aviation organizations.

Addressing this gap is increasingly important as aviation systems become more complex, interconnected, and data-intensive. While digital technologies promise enhanced situational awareness and predictive capability, they also risk reinforcing a narrow focus on data availability at the expense of shared understanding and collective sensemaking (Dekker, 2014). Without robust KM processes, organizations may accumulate vast quantities of safety data while remaining vulnerable to the same systemic failures that have historically preceded major accidents.

The purpose of this paper is to develop a conceptual framework that explains how KM failures function as latent safety risks in aviation organizations. The framework integrates insights from safety science, organizational learning theory, and knowledge management scholarship, and treats KM not as a supportive managerial function but as a core structural component of the aviation safety system. It identifies distinct KM failure modes and clarifies the mechanisms through which they weaken safety defenses. In doing so, the paper advances theoretical understanding and provides a foundation for more effective safety governance and future research.

Transport organisations also face a management problem that sits behind formal safety system design. Senior leaders can invest in reporting, assurance routines, and digital tools, yet still struggle to convert operational experience into shared organisational knowledge that shapes decisions across functions and sites. This paper therefore speaks to transport business and management by framing KM quality as a governance issue. It focuses on who owns knowledge integration, how organisations sustain learning loops beyond procedural closure, and how managers detect slow capability erosion that can persist even when headline indicators remain stable. While the framework is developed in aviation, the logic is relevant to other transport operators and infrastructure organisations where reliability depends on cross-boundary coordination, expertise continuity, and collective interpretation of weak signals.

Existing safety research has primarily examined organizational vulnerabilities through constructs such as safety culture, human factors, and organizational learning, while KM research has focused largely on innovation, performance, and competitive advantage. This paper contributes by bridging these domains and reframing knowledge degradation itself as a latent safety mechanism. Rather than treating KM as a

supporting managerial activity, the framework positions failures in knowledge creation, integration, retention, and interpretation as upstream organizational conditions that shape safety culture, learning depth, and weak-signal detection. In doing so, the paper introduces an explicitly epistemic dimension to systemic safety theory and extends the concept of latent conditions into the domain of organizational knowledge processes.

The remainder of the paper proceeds as follows. Section 2 establishes the theoretical foundations linking safety science, organizational learning, and knowledge management. Section 3 develops the conceptual framework and advances propositions to clarify theoretical mechanisms and support future empirical investigation. Section 4 discusses implications for safety management practice and governance. Section 5 concludes with contributions, limitations, and directions for future research.

This paper uses a conceptual theory-building approach grounded in structured synthesis across safety science, organisational learning, and knowledge management research. The intent is not to provide an exhaustive review of all KM or aviation safety studies, but to integrate complementary theoretical streams to specify mechanisms, clarify scope conditions, and derive propositions that enable empirical testing. The framework was developed iteratively by identifying recurrent knowledge-process breakdowns discussed across these literatures and mapping how they plausibly degrade organisational safety defences over time.

THEORETICAL FOUNDATIONS: SAFETY, KNOWLEDGE, AND LATENT RISK IN AVIATION ORGANIZATIONS

Safety-Critical Organizations and Latent Conditions

Aviation organizations operate within what safety scholars define as safety-critical systems, where failures are rare but can have severe or catastrophic consequences. In such systems, safety is not achieved through the elimination of error, but through the design of organizational structures that anticipate, detect, and absorb failure before it escalates into harm (Reason, 1997; Leveson, 2011). This perspective represents a shift away from attributing accidents to frontline operators toward understanding safety as an emergent property of complex sociotechnical systems.

Central to this shift is the distinction between active failures and latent conditions. Active failures are unsafe acts committed by individuals at the operational front line, whereas latent conditions are systemic weaknesses embedded within organizational processes, structures, and decision-making over time (Reason, 1990). These latent conditions often remain dormant, invisible, and normalized within everyday operations until they align with local circumstances to breach existing safety defenses. The Swiss Cheese Model conceptualizes this process by illustrating how multiple layers of defense – procedures, technology, training, supervision – can be penetrated when underlying organizational weaknesses are not adequately addressed (Reason, 1997).

In aviation, latent conditions frequently emerge from managerial decisions, organizational priorities, and institutional routines rather than from technical design alone. Accident investigations have repeatedly demonstrated that formal compliance with safety regulations can coexist with deep structural vulnerabilities, particularly when organizations rely on procedural conformity as a proxy for safety performance (Dekker, 2014). This insight underscores the need to examine not only whether safety systems exist, but how they function in practice, and specifically, how organizations learn, remember, and adapt in the face of risk.

Knowledge Management as an Organizational Capability

KM provides a critical, yet often implicit, foundation for organizational safety. At its core, KM refers to the processes through which organizations create, integrate, retain, retrieve, interpret, and use knowledge across individuals, groups, and time (Nonaka, 1994). Knowledge exists in both explicit forms, such as procedures, manuals, databases, and regulatory documentation, and tacit forms, including experience-based judgment, practical know-how, and shared understandings that are difficult to codify (Nonaka & Takeuchi, 1995). In safety-critical environments, the effective integration of these two forms of knowledge is essential for reliable performance under varying and uncertain conditions.

In aviation organizations, safety depends not only on the existence of information, but on the organization's capacity to mobilize knowledge across functional, temporal, and professional boundaries. Safety-relevant knowledge is distributed across flight operations, engineering, maintenance, training, safety departments, and managerial functions. Hazards are rarely confined to a single unit; they emerge from interactions between technical systems, operational practices, and organizational decisions. Effective KM therefore requires mechanisms that enable knowledge to move across these boundaries, be interpreted in context, and be translated into coordinated action.

Evidence from aviation training contexts illustrates how knowledge processes in high-risk environments can be constrained in ways that unintentionally weaken learning quality. A case study of an aviation school highlights how strong standardization pressures can encourage formal information gathering and dissemination while discounting the contextual and social conditions needed for effective knowledge transfer (Vrahimi & Mancera, 2019). In such settings, trial-and-error learning is limited because mistakes can carry unacceptable consequences, which increases reliance on institutionalized knowledge and near-miss learning rather than experiential failure (Vrahimi & Mancera, 2019). This dynamic reinforces the present argument that KM failures can persist even in organizations oriented toward safety and reliability, because the central issue is not the presence of information, but whether knowledge becomes shareable, interpretable, and usable across people and time.

Aviation organizations rely heavily on codified knowledge to standardize operations and reduce variability. Standard Operating Procedures, training programs, and regulatory documentation are designed to capture accumulated experience and embed it into routine practice. However, the existence of formal documentation does not guarantee that knowledge is understood, internalized, or meaningfully applied. KM failures can occur when knowledge is reduced to static artifacts, disconnected from the contexts in which it must be enacted (Brown & Duguid, 2001). Over time, this disconnection can erode organizational learning and weaken the organization's ability to respond to novel or unexpected situations.

For example, maintenance incident reports may remain confined within engineering databases without being translated into operational training. Lessons identified in safety investigations may be formally documented but fail to shape everyday decision-making on the flight deck or in line maintenance. Similarly, outsourcing or workforce turnover may disrupt mentoring relationships that sustain tacit operational expertise, leaving organizations increasingly dependent on formal procedures that cannot fully capture situational judgment. In such cases, knowledge exists somewhere within the organization, but not in forms or locations where it can support safe action.

It is also important to distinguish KM from related organizational constructs frequently discussed in safety research. Safety culture refers to shared values and assumptions about risk, whereas KM concerns the processes through which safety-relevant knowledge is created, integrated, and sustained over time. Communication focuses on the transmission of messages, while KM addresses whether knowledge is interpreted, retained, and used meaningfully across contexts. Organizational learning describes how organizations adapt to feedback, but often leaves implicit the mechanisms through which knowledge is captured, stored, or lost. Information systems provide technical infrastructures for data storage and retrieval, yet KM concerns the broader organizational capability that transforms information into shared understanding and coordinated practice. In this sense, KM operates at the epistemic foundation of these constructs, shaping the conditions under which culture, learning, and communication processes become effective.

Importantly, KM is not merely about the storage or transmission of information, but about interpretation and sensemaking. Organizations must continually update their understanding of risk as operational environments evolve. When knowledge flows are fragmented across functional silos, critical insights may fail to circulate, leading to partial or distorted understandings of safety threats. In such cases, knowledge exists within the organization, but not for the organization.

From a safety perspective, KM can therefore be understood as an organizational capability that sustains institutional memory, supports coordinated action, and enables continuous reinterpretation of risk. When this capability weakens, knowledge becomes fragmented, outdated, or decoupled from practice. Such degradation does not typically produce immediate operational failures. Instead, it manifests gradually

through reduced shared understanding, weakened learning processes, and increasing reliance on individual vigilance. In this way, breakdowns in KM create the kinds of latent organizational conditions that safety science identifies as precursors to major accidents (Reason, 1997). This insight provides the basis for examining KM failures not simply as managerial shortcomings, but as structural safety risks within aviation organizations.

Organizational memory provides an important foundation for this capability. Organizations retain knowledge through individuals, routines, procedures, information systems, and cultural practices that preserve experience across time (Walsh & Ungson, 1991). Information systems can support this process by storing and making knowledge accessible, but memory becomes organizationally valuable only when knowledge remains interpretable and usable in operational contexts (Stein & Zwass, 1995). In aviation settings, degradation of organizational memory may weaken the continuity of safety knowledge and reduce the organization's ability to learn from past events.

Organizational Learning, Sensemaking, and Safety

The link between KM and safety becomes clearer when examined through the lens of organizational learning. Argyris and Schon (1978) distinguish between single-loop learning, which focuses on correcting deviations within existing rules and assumptions, and double-loop learning, which involves questioning and revising the underlying norms, goals, and mental models that guide organizational behavior. While aviation organizations are generally effective at single-loop learning – updating procedures following incidents or audits – they often struggle with double-loop learning when safety issues challenge established hierarchies, expertise boundaries, or performance pressures.

High Reliability Organization (HRO) theory further emphasizes the role of continuous learning and sensemaking in maintaining safety under conditions of complexity and uncertainty. HROs are characterized by a preoccupation with failure, reluctance to simplify interpretations, sensitivity to operations, commitment to resilience, and deference to expertise (Weick & Sutcliffe, 2001). Each of these principles depends fundamentally on the organization's capacity to mobilize knowledge across levels and domains. When knowledge is centralized, filtered, or selectively interpreted, these principles are undermined, even if formal safety systems remain intact.

Furthermore, the sensemaking theory highlights how organizations construct meaning from ambiguous and incomplete information (Weick, Sutcliffe, & Obstfeld, 2005). In aviation, sensemaking is particularly critical for interpreting weak signals, near-misses, and deviations that may not immediately appear hazardous. KM failures such as inadequate feedback loops, poor integration of incident data, or overreliance on quantitative indicators, can impair sensemaking by privileging what is easily measurable over what is contextually significant. As a result, organizations may accumulate large volumes of safety data while failing to recognize emerging risks.

Knowledge Management Failures as Latent Safety Risks

Integrating safety science, knowledge management, and organizational learning reveals how breakdowns in knowledge processes can function as latent safety risks. Unlike technical failures or frontline errors, KM failures rarely produce immediate operational consequences. Instead, they manifest gradually through the erosion of institutional memory, the fragmentation of expertise, and the decoupling of safety information from operational decision-making. Over time, these processes weaken multiple layers of safety defense, reducing organizational resilience and increasing dependence on individual vigilance rather than systemic robustness (Reason, 1997).

In this paper, knowledge degradation refers to the progressive deterioration of an organization's ability to create, retain, integrate, transfer, and interpret safety-relevant knowledge. Such degradation may emerge through fragmentation, forgetting, expertise loss, weakened learning processes, or impaired sensemaking. Over time, these processes reduce organizational capacity to anticipate hazards, adapt to changing conditions, and sustain reliable performance.

From a causal perspective, KM failures degrade the organization's ability to interpret, integrate, and act on safety-relevant knowledge. When knowledge flows become fragmented, hazards may be recognized

locally but not understood systemically. When tacit expertise erodes, organizations become more dependent on formal procedures that cannot fully account for operational variability. When learning loops become superficial or compliance-oriented, recurring problems may be addressed symptomatically rather than structurally. When sensemaking processes narrow, weak signals and emerging risks may be normalized or overlooked. These mechanisms collectively reduce the effectiveness of safety defenses long before any accident occurs.

This dynamic can be illustrated through a typical aviation scenario. A recurring maintenance anomaly may be reported across several bases, with each location addressing the issue through local corrective actions. Incident reports are filed and archived, and procedures are formally updated. However, if knowledge integration mechanisms are weak, the pattern may never be recognized as a systemic issue. Engineering, maintenance, and operations units may interpret the events differently, and lessons learned may remain confined within separate reporting systems. Over time, the anomaly becomes normalized as a routine irregularity, while the underlying hazard persists. In this way, the organization appears procedurally compliant and operationally stable, even as latent risk accumulates within its knowledge processes.

Understanding KM failures in this way highlights their structural role in the emergence of other organizational vulnerabilities. Communication breakdowns, weak safety culture, or limited organizational learning are often treated as primary causes of accidents. However, these phenomena frequently represent downstream manifestations of deeper problems in how knowledge is created, integrated, and sustained. Fragmented knowledge flows can distort communication. Eroded institutional memory can weaken safety culture by disconnecting present practices from past experience. Superficial learning loops can give the appearance of organizational learning without altering underlying assumptions. KM failures therefore operate at an epistemic level, shaping the conditions under which other safety-related constructs emerge.

From this perspective, KM failures represent a distinct class of latent conditions that weaken multiple layers of defense simultaneously. Inadequate knowledge transfer can compromise training effectiveness; fragmented knowledge flows can distort risk assessments; and poor learning mechanisms can allow known hazards to persist unchallenged. These failures often remain invisible within conventional safety metrics, which focus on accident rates, compliance indicators, or audit findings, rather than on the quality of organizational knowledge processes.

Understanding KM failures as latent safety risks provides a conceptual bridge between safety management and organizational knowledge theory. It suggests that safety cannot be sustained solely through procedural controls or technological systems, but depends on the organization's capacity to continuously create, integrate, and reinterpret knowledge in response to evolving operational realities. This insight forms the basis for the conceptual framework developed in the following section, which explicates the mechanisms through which KM failures undermine safety defenses in aviation organizations.

This framing also enables a more direct connection between KM failures and the logic of Safety Management Systems. ICAO-aligned SMS frameworks are typically organized around safety policy and objectives, safety risk management, safety assurance, and safety promotion (Kıvanç et al., 2025; Stroeve et al., 2022). Fragmentation of safety-relevant knowledge undermines risk management by distorting hazard interpretation and weakening the integration of evidence across functions. Erosion of tacit expertise weakens both assurance and promotion by reducing the organization's capacity to translate experience into reliable practice and learning. Deficient learning loops compromise assurance by turning audits, investigations, and reporting into documentation rather than usable knowledge. Impaired sensemaking undermines the entire SMS cycle by privileging what is measurable over what is operationally meaningful. In this way, KM failures do not sit outside SMS; they shape whether SMS processes produce genuine learning and adaptive control in practice.

Positioning KM Failures Among Latent Organizational Conditions

Safety science has long emphasized that accidents in complex sociotechnical systems emerge from interacting latent organizational conditions rather than isolated operational failures. Accordingly, constructs such as safety culture, organizational learning, communication quality, and training effectiveness occupy a central place in aviation safety research. While these constructs capture important dimensions of

organizational performance, they do not fully account for how safety–relevant understanding is created, sustained, and transformed across time and organizational boundaries. This paper argues that knowledge management failures constitute a distinct and upstream class of latent conditions that shape and constrain these more commonly examined phenomena.

Safety culture reflects shared values and assumptions about risk, yet the formation and persistence of such shared understandings depend on underlying knowledge processes through which experience is interpreted and institutionalized. Similarly, organizational learning frameworks describe how organizations respond to feedback, but often leave implicit the mechanisms through which knowledge is integrated, retained, or lost. Communication failures, frequently cited in accident investigations, often represent surface manifestations of deeper structural problems in how knowledge is filtered, legitimized, and mobilized within the organization.

By contrast, KM failures operate at a more fundamental level. They concern the integrity of the processes through which safety–relevant knowledge is created, shared, interpreted, and embedded in practice. Fragmented knowledge flows, erosion of tacit expertise, shallow learning loops, and impaired sensemaking do not merely coexist with weak safety culture or limited learning capacity; they actively shape the conditions under which these outcomes emerge. In this sense, KM failures function as latent enablers of other organizational vulnerabilities.

Positioning KM failures in this way does not replace existing safety constructs but complements them by shifting analytical attention to the epistemic foundations of organizational safety. This perspective helps explain why organizations may display positive safety indicators, high reporting activity, and formal learning mechanisms while remaining vulnerable to systemic failure. Knowledge management failures therefore represent a critical, yet often invisible, layer of latent safety risk that warrants explicit theoretical and practical attention in aviation safety research and governance.

A CONCEPTUAL FRAMEWORK OF KM FAILURES AS LATENT SAFETY RISKS IN AVIATION ORGANIZATIONS

This section develops a conceptual framework that explains how failures in knowledge management function as latent safety risks within aviation organizations. Building on safety science, organizational learning, and KM theory, the framework conceptualizes safety not as a direct outcome of procedures or technologies, but as an emergent property shaped by the quality of organizational knowledge processes over time. The framework is intended to provide an integrative lens through which KM failures can be systematically identified, analyzed, and addressed as part of aviation safety governance.

Framework Logic and Scope

The proposed framework is grounded in the assumption that aviation safety is sustained through multiple, interdependent organizational defenses, consistent with systemic safety models. Within this structure, KM operates as a cross–cutting organizational capability that enables the creation of shared understanding, the retention of institutional memory, and the translation of experience into coordinated action. When KM processes degrade, they do not typically trigger immediate operational failures. Instead, they weaken safety defenses gradually, creating latent conditions that increase vulnerability to future incidents.

The framework therefore follows a simple mechanism chain. KM failures first degrade how the organisation integrates, retains, and interprets safety–relevant knowledge. Degraded knowledge processes then weaken safety defences by reducing weak–signal detection, lowering learning depth (and increasing recurrence of known patterns), and narrowing non–routine adaptive performance at the operational front line. These effects can accumulate quietly, so organisations may remain stable and procedurally compliant while epistemic weaknesses build beneath conventional indicators.

The unit of analysis is the organisation's capability to maintain knowledge quality across operational interfaces, rather than any single event, department, or technical system. The framework is most relevant where operations span multiple sites, professional communities, and contracted or partnered activities, and

where performance depends on coordinated interpretation of safety–relevant information over time. It is less suited to loosely coupled or low–consequence settings where knowledge fragmentation does not materially affect operational reliability. This scope alignment supports an RTBM–style reading of KM failures as a management and governance challenge that shapes organisational performance under complexity.

The framework adopts a mechanism–based logic. KM failure modes degrade core knowledge processes – integration across boundaries, retention of institutional memory, transformation of experience into organizational learning, and collective interpretation of ambiguous signals. These degraded knowledge processes, in turn, weaken specific safety defenses, including cross–functional coordination, adaptive expertise at the operational front line, the organization's capacity for learning beyond compliance, and shared sensemaking about risk. As these defenses erode, knowledge–related weaknesses accumulate as latent organizational conditions, narrowing margins of safety and increasing dependence on individual vigilance rather than systemic resilience (Reason, 1997).

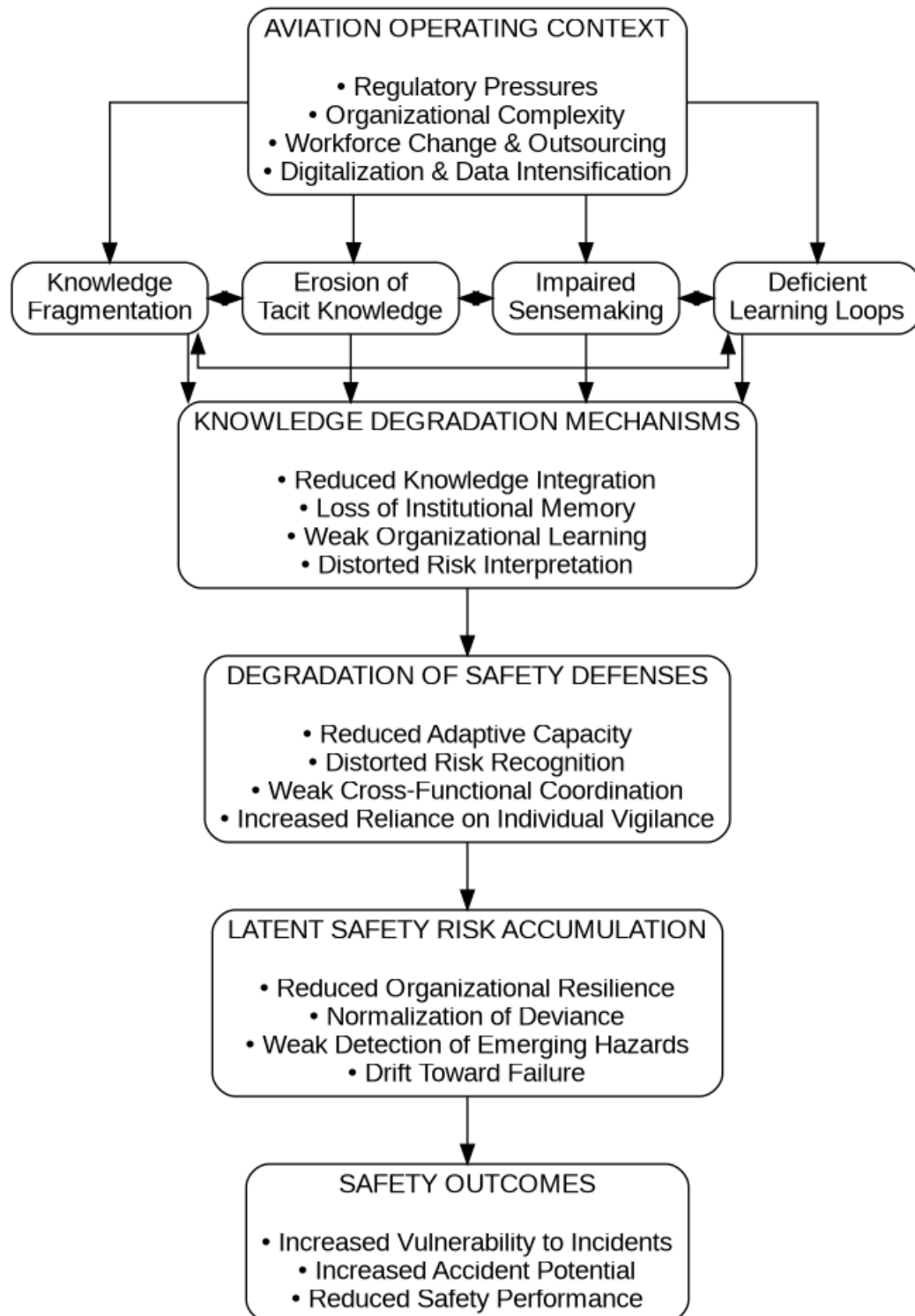
Figure 1 summarizes this logic. The four KM failure modes are depicted as interacting latent conditions rather than a linear sequence or staged maturity model. The arrows represent reinforcing influence pathways between failure modes, not formal reporting lines and not deterministic causal claims. "Accumulation" in Figure 1 refers to the gradual build–up of epistemic weaknesses over time, as small breakdowns in integration, transfer, learning, and interpretation become normalized within everyday work and begin to interact. The framework therefore emphasizes that organizations can remain procedurally compliant and operationally stable while the quality of knowledge processes deteriorates beneath conventional indicators.

Several reinforcing mechanisms, reflected in the influence pathways shown in Figure 1, clarify how the failure modes amplify one another. Knowledge fragmentation across functions can produce inconsistent interpretations of similar incidents, encouraging localized corrective actions that do not travel across boundaries. This limits organizational learning and reinforces fragmentation as lessons remain siloed. Erosion of tacit expertise can increase reliance on codified procedures and compliance–driven workarounds. Over time, this reliance reduces opportunities for situated judgment and mentoring, which further accelerates tacit knowledge loss. Deficient learning loops – where audits, reporting, and investigations generate documentation rather than shared understanding – can narrow organizational attention to what is measurable, thereby weakening sensemaking and increasing the risk that weak signals are normalized. In turn, impaired sensemaking discourages cross–boundary dialogue and critical interpretation, further entrenching fragmentation and shallow learning.

A drift scenario illustrates how the framework operates as a latent dynamics model rather than an event–based explanation. Consider an organization experiencing gradual workforce turnover and outsourcing that reduces informal mentoring and experiential knowledge sharing. Tacit knowledge erosion increases dependence on formal procedures and compliance–style learning. Safety data continues to be collected through reporting and monitoring, but interpretation becomes increasingly centralized and indicator–driven, privileging what is visible in dashboards over what is operationally meaningful. Fragmentation across functions prevents patterns from being recognized as systemic, and weak signals are treated as routine irregularities. Each element of the SMS may appear complete on paper, yet the combined effect is a progressive erosion of multiple safety defenses, moving the organization closer to hazardous conditions without any single triggering failure.

The framework illustrates how aviation operating conditions contribute to four interacting KM failure modes: knowledge fragmentation, erosion of tacit knowledge, deficient learning loops, and impaired sensemaking. These failures generate knowledge degradation mechanisms that weaken safety defenses, accumulate as latent safety risks, and increase vulnerability to adverse safety outcomes.

FIGURE 1
CONCEPTUAL FRAMEWORK OF KNOWLEDGE MANAGEMENT FAILURES AS LATENT
SAFETY RISKS IN AVIATION ORGANIZATIONS



SOURCE: AUTHORS' ELABORATION

Core KM Failure Modes

The framework identifies four interrelated KM failure modes that function as latent safety risks in aviation organizations.

The first failure mode concerns knowledge fragmentation. Aviation organizations are structurally differentiated into specialized units such as operations, safety, engineering, training, and management. While specialization is necessary for efficiency, it can lead to fragmented knowledge flows when information is not effectively integrated across boundaries. Safety-relevant insights may remain confined within functional silos, resulting in weaker cross-boundary weak-signal detection and misaligned decision-making. Over time, fragmentation undermines shared understanding of system-wide risks and reduces the organization's capacity to coordinate responses to emerging threats.

The second failure mode relates to the erosion of tacit knowledge. Much of aviation safety depends on experiential knowledge accumulated through practice, mentoring, and informal interaction. This knowledge is particularly vulnerable to loss through workforce turnover, retirement, outsourcing, and organizational restructuring. When tacit knowledge is not actively cultivated or transmitted, organizations become increasingly reliant on formal procedures that may lack the contextual richness required for effective judgment under uncertainty. The erosion of tacit knowledge reduces non-routine adaptive performance and increases dependence on rule-based compliance.

Research within the aviation sector has highlighted the importance of structured knowledge transfer and succession planning mechanisms in preserving critical expertise. As experienced personnel retire or leave organizations, insufficient transfer of operational knowledge can create discontinuities in organizational memory and reduce the availability of experiential knowledge required for effective decision-making. Knowledge continuity practices therefore represent an important safeguard against the erosion of tacit knowledge and the accumulation of latent organizational vulnerabilities (Uwayezu & El Asri, 2023).

The third failure mode involves deficient learning loops. Aviation organizations generate extensive safety data through incident reports, audits, and monitoring systems. However, the transformation of this data into organizational knowledge is neither automatic nor guaranteed. Learning failures occur when feedback loops are superficial, narrowly corrective, or focused solely on compliance outcomes. In such cases, organizations may repeatedly address symptoms without confronting underlying assumptions, limiting opportunities for double-loop learning and systemic improvement.

The fourth failure mode concerns impaired sensemaking. Sensemaking refers to the collective process through which organizations interpret ambiguous information and construct shared meaning about risk. KM failures can impair sensemaking by privileging quantitative indicators over qualitative insights, discouraging dissenting interpretations, or over-centralizing knowledge interpretation within managerial or technical elites. When sensemaking is constrained, weak signals and emerging hazards may be normalized or dismissed, allowing latent risks to persist unchallenged.

While analytically distinct, the four KM failure modes identified in this framework are not independent. Rather, they represent interrelated mechanisms through which organizational knowledge degrades over time. Knowledge fragmentation constrains shared understanding, erosion of tacit knowledge reduces non-routine adaptive performance, deficient learning loops limit systemic correction, and impaired sensemaking distorts risk interpretation. Each failure mode captures a different dimension of how knowledge-related vulnerabilities emerge and interact, allowing them to be examined separately while recognizing their cumulative impact on safety defenses. This distinction provides a basis for future empirical work to operationalize KM failures as observable organizational conditions rather than abstract cultural attributes.

KM Failures and the Degradation of Safety Defenses

The framework conceptualizes KM failure modes as mechanisms that progressively degrade multiple layers of safety defenses. Knowledge fragmentation can compromise coordination and communication, erosion of tacit knowledge can weaken frontline adaptability, deficient learning loops can stall organizational learning, and impaired sensemaking can distort risk perception. Individually, these failures

may appear manageable or inconsequential; collectively, they interact to reduce organizational resilience and narrow margins of safety.

Importantly, these failures often remain invisible within conventional safety performance indicators. Accident rates, audit scores, and compliance metrics may remain stable even as underlying knowledge processes deteriorate. As a result, organizations may develop a false sense of safety confidence, increasing reliance on formal controls while overlooking deeper vulnerabilities. This dynamic aligns with the concept of drift toward failure, whereby organizations gradually move closer to hazardous states without recognizing the cumulative impact of small deviations (Dekker, 2011).

Propositions

In this paper, three outcome constructs capture how KM failures translate into latent safety risk. Weak-signal detection refers to the organisation's ability to notice, escalate, and interpret early indications of emerging hazards across operational boundaries, before they consolidate into recurrent disruptions or incidents. Learning depth and recurrence refers to the extent to which corrective action goes beyond local fixes to address underlying mechanisms, reflected in a reduced reappearance of known issue types over time and across sites. Non-routine adaptive performance refers to the quality of operational decision-making and coordination under novel, ambiguous, or fast-changing conditions, when procedures provide limited guidance and teams must integrate expertise to act safely and effectively.

The framework yields the following propositions:

***P1:** Greater cross-boundary fragmentation of safety knowledge is associated with reduced detection and interpretation of weak signals, controlling for reporting volume.*

Measured through cross-unit taxonomy alignment, cross-site synthesis routines, and recurrence of similar events across units.

***P2:** Higher erosion of tacit knowledge is associated with reduced non-routine adaptive performance and increased reliance on procedural compliance.*

Measured through mentoring intensity, turnover in critical roles, skill-mix stability, and non-routine performance deviations.

***P3:** Organizations with compliance-dominant learning loops will exhibit higher recurrence of similar incident patterns than organizations with inquiry-oriented learning loops, despite similar SMS maturity.*

Measured through recurrence patterns, depth of corrective actions, and evidence of assumption-challenging (double-loop) outcomes.

***P4:** Investments in safety data and analytics improve weak-signal detection, learning depth, and non-routine adaptive performance only when accompanied by strong interpretive capacity; otherwise, data abundance increases the risk of miscalibration.*

Interpretive capacity refers to the organisation's ability to translate data into operational meaning through shared frames, cross-functional debate, and accountable decisions, rather than through dashboards alone. Miscalibration describes a systematic gap between what indicators suggest and what frontline conditions require, leading to delayed escalation, misplaced confidence in control, or repeated operational surprises during disruption. Measured through interaction between analytics investment and interpretive forums' maturity; outcomes reflected in miscalibration signals (e.g., indicator stability alongside recurring weak signals).

P5: Organizations experiencing simultaneous KM fragmentation and tacit knowledge erosion will exhibit disproportionately lower non-routine adaptive performance than organizations experiencing either condition alone.

Measured through interaction effects in quantitative models or cross-case comparison of combined failure conditions.

It is worth noting that the scope of the proposed framework is primarily bounded to safety-critical and high-reliability organizational contexts in which failure consequences are severe and knowledge processes are tightly coupled to operational performance. The framework is therefore most applicable to domains such as aviation, healthcare, nuclear power, and other complex sociotechnical systems where safety depends on continuous learning, expertise integration, and collective sensemaking.

Within aviation, the framework is most salient where cross-unit interdependence and non-routine work are frequent, and where safety knowledge must travel across boundaries. This includes multi-base operations, heavy outsourcing in maintenance or ground handling, rapid turnover in safety-critical roles, parallel safety data systems without a shared taxonomy, and complex interfaces across airline, airport, ANSP, and vendor organisations. These conditions amplify fragmentation, accelerate tacit knowledge loss, and increase reliance on structured sensemaking beyond local optimisation.

In contrast, the framework is less directly applicable to low-risk or loosely coupled environments where knowledge fragmentation or tacit knowledge erosion does not produce immediate safety consequences. These boundary conditions reflect the framework's focus on knowledge processes as latent safety mechanisms rather than as general drivers of organizational performance or innovation.

The propositions support several tractable empirical designs. Comparative case studies across bases, fleets, or business units can trace how fragmentation and learning-loop quality relate to recurrence patterns, escalation timing, and weak-signal interpretation. Longitudinal studies within one organisation can examine whether changes in mentoring coverage, turnover in critical roles, and taxonomy alignment predict shifts in non-routine adaptive performance and the recurrence of known issue types. Mixed-method designs can combine interviews and document analysis with quantitative mapping of safety-report taxonomies, lesson diffusion lag, and network patterns of knowledge transfer to test both the mechanisms and the outcomes proposed.

Evidence of rapid cross-site lesson diffusion, stable taxonomy alignment, and high-quality sensemaking under disruption, alongside low recurrence of known issue types, would weaken the claim that KM failures operate as latent safety risks in the studied setting.

Operationalization of KM Failures

The four KM failure modes proposed in this framework can be operationalized through observable organizational artifacts, practices, and outcomes. While the framework is conceptual, each failure mode corresponds to concrete organizational conditions that can be examined empirically through document analysis, interviews, safety data, and observational studies. Knowledge fragmentation may be observed in the existence of multiple incident or hazard databases across functions without shared taxonomies, inconsistent procedural updates across operational units, or safety reviews conducted within functional silos rather than through cross-boundary forums. Such fragmentation often manifests in the recurrence of similar anomalies across departments without systemic recognition, reflecting weak integration of safety-relevant knowledge (Brown & Duguid, 2001; Weick & Sutcliffe, 2001).

Erosion of tacit knowledge can be examined through indicators such as the absence of mentoring or apprenticeship structures, shortened training cycles focused on procedural compliance, or outsourcing arrangements that disrupt continuity of expertise. Observable outcomes may include increased dependence on rule-based responses, reduced adaptability in non-routine situations, and brittle operational performance under unexpected conditions, consistent with research on high-reliability organizations and resilience (Roe & Schulman, 2008; Woods, 2015). These measures may be complemented by KM-specific indicators related to knowledge creation, retention, sharing, and utilization, which have recently been proposed for aviation performance assessment (El Asri, Tsiakalos, & Anakkar, 2025).

Deficient learning loops can be identified where incident reports, audits, and investigations generate documentation without leading to systemic change. Empirical signs include repeated corrective actions for similar issues, administrative closure of investigation findings, or safety meetings focused primarily on compliance metrics rather than interpretive learning. Such patterns align with single-loop learning dynamics, where organizations correct deviations without questioning underlying assumptions (Argyris & Schon, 1978).

Impaired sensemaking may be visible in heavy reliance on aggregated dashboards, limited qualitative interpretation of near-misses, centralized data interpretation, or the normalization of weak signals. Outcomes may include delayed recognition of emerging hazards or overconfidence in stable indicators despite underlying variability, reflecting the importance of collective interpretation in complex systems (Weick, Sutcliffe, & Obstfeld, 2005; Woods, 2015).

These indicators enable empirical tests of P1–P5 by mapping each failure mode to observable boundary-crossing integration patterns, expertise continuity conditions, learning-loop depth, and interpretive practices.

DISCUSSION: KM AS A LATENT DIMENSION OF AVIATION SAFETY

The framework explains how aviation organizations can maintain the appearance of safety control while progressively losing their capacity to learn, adapt, and anticipate emerging risks, thereby transforming knowledge-related weaknesses into latent safety threats.

Contributions to Contemporary Safety Science and KM

The framework contributes to safety science by extending the concept of latent organizational conditions to include failures in knowledge creation, integration, and retention. While the role of latent conditions in accident causation is well established (Reason, 1997; Leveson, 2011), more recent scholarship has emphasized that modern safety challenges increasingly stem from organizational complexity, information overload, and degraded learning processes rather than from technical unreliability alone (Hollnagel, 2014). By making KM failures analytically explicit, the framework provides a mechanism-level explanation for how such vulnerabilities accumulate within ostensibly well-managed safety systems.

This contribution aligns with contemporary developments in safety thinking, particularly the shift toward systems-based and resilience-oriented perspectives. Safety-II and resilience engineering research emphasizes the importance of learning, adaptation, and performance variability in sustaining safety under changing conditions (Hollnagel, 2014; Woods, 2015). The framework complements this work by identifying how weak or fragmented KM processes constrain organizational learning and sensemaking, thereby limiting the organization's ability to adapt safely.

From a KM perspective, the framework responds to recent calls to re-examine knowledge processes in high-risk and regulated environments. While early KM research focused primarily on innovation and competitive advantage (Nonaka & Takeuchi, 1995), more recent studies highlight the role of knowledge integration, continuity, and interpretive capacity in complex organizations operating under conditions of uncertainty (Grant, 2013; Hislop, Bosua, & Helms, 2018). In aviation, where failures carry severe consequences, the erosion of these capabilities represents not just a performance risk but a safety threat.

This framework does not replace constructs such as safety culture or organizational learning. It positions KM failures as upstream epistemic conditions that shape how such constructs emerge and operate in practice.

Implications for Aviation Safety Management Practice

The framework has direct implications for how aviation organizations understand and implement safety management. Despite widespread adoption of SMS, empirical studies and accident analyses continue to report persistent learning failures, weak feedback loops, and limited organizational reflection (Dekker, 2014). The framework helps explain why such failures persist by showing how KM breakdowns can remain hidden beneath formal compliance structures and positive safety indicators.

From a transport business and management perspective, the framework shifts attention from whether a safety system exists to whether management has effective control over learning quality. This control depends on governance routines that make knowledge integration visible and discussable at the right levels. In practice, managers need mechanisms that expose how safety knowledge travels across operational boundaries, how lessons translate into decisions, and whether local fixes accumulate without organisational synthesis. The framework therefore treats KM not as a supporting administrative function, but as a management control domain that influences organisational reliability, resilience, and operational consistency.

Organizations can emphasize reporting volume and procedural completeness over the quality of learning and interpretation. In such contexts, safety data may be abundant, yet poorly integrated into operational decision-making. The framework therefore shifts attention from data collection alone to the processes through which safety knowledge is interpreted, integrated, and translated into coordinated action. This perspective highlights the importance of practices that support cross-functional dialogue, critical questioning, and collective reflection on operational experience.

A practical implication is that organizations should evaluate not only whether safety information exists, but whether it becomes trusted, shared, and usable across functions. Safety assurance activities typically rely on audits, investigations, indicators, and employee reporting, yet these inputs only improve safety when they are transformed into shared organizational knowledge that shapes operational decisions (Kıvanç et al., 2025). Evidence from aircraft maintenance contexts shows that learning depends on structured systems that collect safety information and communicate it effectively for both individual and organizational learning (Tyagi et al., 2023). KM-oriented indicators can therefore complement traditional compliance metrics by tracking the quality of knowledge integration, retention, and use (El Asri et al., 2025).

In practical terms, this perspective suggests several areas of managerial attention. Organizations can establish cross-functional safety interpretation forums where operational, engineering, and safety personnel jointly review incident patterns rather than treating them within isolated departments. They can invest in mentoring structures, communities of practice, and expertise retention programs to mitigate erosion of tacit knowledge. Learning-loop audits can be introduced to examine whether corrective actions produce systemic understanding rather than administrative closure. Finally, organizations can complement traditional safety dashboards with interpretive reviews that incorporate qualitative insights, dissenting perspectives, and weak-signal analysis. Such practices shift the focus of safety management from procedural completeness toward the quality of organizational knowledge processes that sustain safe performance over time.

The erosion of tacit knowledge represents a particularly salient risk in contemporary aviation organizations facing demographic change, outsourcing, and increasing reliance on standardized processes. Studies in safety-critical domains show that loss of experiential knowledge reduces non-routine adaptive performance and increases brittleness in unexpected situations (Woods, 2015; Roe & Schulman, 2008). The framework therefore reinforces the importance of mentoring, experiential learning, and knowledge continuity mechanisms as safety-relevant investments rather than optional human resource initiatives.

Implications for Safety Governance and Regulatory Oversight

At the governance level, the framework raises important questions about how safety oversight evaluates organizational capability. For executive governance, the practical question becomes how to assure knowledge quality in the same way organisations assure financial and operational performance. The framework suggests a small set of management controls that can sit alongside SMS governance: clear decision rights for cross-unit learning, formal routines for interpreting weak signals with operational leaders present, and performance review criteria that examine learning depth rather than closure rates. Governance can also require evidence that lessons travel across sites and contractors, that tacit expertise risks have owners and mitigation plans, and that safety dashboards trigger interpretive discussion rather than replacing it. These controls help decision-makers detect capability erosion early, before it appears in outcome indicators or audit findings.

Regulatory audits and SMS assessments typically focus on the presence of documented processes, defined responsibilities, and reporting mechanisms. However, recent critiques of regulatory practice suggest that such assessments often fail to capture how organizations actually learn and adapt in practice (Dekker, 2014).

One practical way to make this gap assessable is to complement compliance-oriented checks with SMS maturity assessment approaches that evaluate how safety management works in practice. Aviation safety management research notes that SMS can drift towards bureaucratic performance, where documentation and reporting outputs become proxies for capability, even when learning and adaptation remain weak (Stroeve et al., 2022). Maturity-oriented assessment helps shift attention to the quality of feedback loops, including how information travels across functions, how it is interpreted, and how it is translated into changes in procedures, training, and operational decision-making (Stroeve et al., 2022). This supports the argument that oversight can improve not by adding more requirements, but by broadening what counts as evidence of organizational control and resilience.

The framework suggests that safety governance could be strengthened by incorporating attention to learning quality, knowledge integration, and sensemaking processes. This aligns with systems-theoretic approaches to regulation, which emphasize that effective control depends not only on formal rules but on how information flows and is interpreted within organizations (Leveson, 2011). Without such attention, regulatory oversight may inadvertently reinforce a compliance-oriented mindset that masks deeper vulnerabilities.

Relevance in Digitally Mediated and High-Complexity Environments

The relevance of the proposed framework is heightened by the ongoing digital transformation of aviation systems. Advanced analytics, automation, and integrated operations centers have expanded organizations' capacity to monitor performance and detect deviations. However, recent safety research cautions that digitalization can also amplify knowledge fragmentation and reduce shared understanding if not accompanied by strong interpretive and learning practices (Hollnagel, 2014).

This is also why the move towards data-rich safety management does not automatically translate into stronger learning. Annex 19-oriented SMS implementation aims to draw on employees' knowledge, experience, and suggestions as inputs to safety improvement, not only on technical monitoring outputs (Tyagi et al., 2023). In practice, digital systems can increase speed and visibility while still leaving organizations vulnerable if they cannot integrate information into a shared operational picture, test competing interpretations, and institutionalize lessons across time. In such conditions, organizations may produce stable dashboards and high reporting volume while missing the epistemic quality of what is being learned and acted on, which is consistent with the drift risks identified in aviation SMS research (Stroeve et al., 2022).

Studies of complex sociotechnical systems indicate that over-reliance on dashboards and indicators can obscure weak signals and suppress alternative interpretations of risk (Woods, 2015). The framework offers a critical lens for assessing such developments by emphasizing that safety depends on collective sensemaking rather than information availability alone. In this sense, it provides a durable conceptual foundation for understanding safety risks across different technological regimes, from traditional operations to highly automated environments.

Recent evidence from the airline context also suggests that the relationship between emerging technologies and resilience is contingent on how organizations integrate and govern technology use. Survey findings from Middle Eastern airlines indicate that the adoption of emerging technologies within a resilient organizational culture, and the presence of clear integration plans, align with stronger perceived organizational resilience, whereas more ad hoc leveraging of technologies can associate with weaker resilience (Tsiakalos & El Asri, 2025). Read alongside the present framework, this supports a simple interpretation: technology can expand informational capacity, but it does not resolve the organizational work of integration, interpretation, and institutionalization. In digitally mediated environments, KM failure therefore remains a plausible latent risk even when technical capability appears to improve.

CONCLUSION

This paper has argued that knowledge management failures constitute a critical yet under-theorized class of latent safety risks in aviation organizations. Although the framework is developed in aviation, it also supports transport management research by specifying how knowledge quality operates as an organisational control problem under distributed, safety-critical operations. By integrating safety science, organizational learning, and knowledge management theory, the proposed framework reframes safety as an emergent organizational capability grounded in the quality of knowledge creation, integration, and sensemaking. The central theoretical contribution lies in positioning KM failures as a distinct and upstream form of latent condition. Rather than treating communication breakdowns, weak safety culture, or limited organizational learning as isolated phenomena, the framework shows how these outcomes can emerge from deeper degradations in knowledge processes. In doing so, the paper extends established systemic perspectives on accident causation (Reason, 1997; Leveson, 2011) by introducing an explicitly epistemic dimension of organizational safety.

From a practical and governance perspective, the framework highlights the limitations of compliance-oriented safety management approaches that emphasize documentation, reporting volume, and procedural completeness. Sustained safety depends not only on the presence of formal SMS structures, but on the organization's capacity to convert safety information into shared understanding and coordinated action. This implies a shift in managerial attention toward cross-functional knowledge integration, mentoring and expertise retention, interpretive safety forums, and learning processes that move beyond administrative closure toward systemic reflection. At the regulatory level, the framework suggests that safety oversight may be strengthened by complementing compliance checks with assessments of organizational learning quality, knowledge integration, and sensemaking practices.

The conceptual nature of this study limits empirical generalization, but it provides a theoretically grounded basis for future research. The four KM failure modes and associated propositions offer a starting point for qualitative case studies, longitudinal analyses, and mixed-method investigations across different aviation contexts. Future research may examine how KM failures accumulate over time, how they interact with other organizational conditions, and how interventions in knowledge processes influence safety outcomes. More broadly, by foregrounding knowledge as a latent dimension of safety, this paper invites scholars, practitioners, and regulators to reconsider organizational learning capacity itself as a safety-critical resource in increasingly complex and data-intensive aviation systems.

Nevertheless, the framework provides a theoretically grounded basis for future research. The four KM failure modes and associated propositions offer a starting point for qualitative case studies, longitudinal analyses, and mixed-method investigations across different aviation contexts. Future research may examine how KM failures accumulate over time, how they interact with other organizational conditions, and how interventions in knowledge processes influence safety outcomes.

REFERENCES

- Argyris, C., & Schon, D.A. (1978). *Organizational learning: A theory of action perspective*. Addison-Wesley.
- Brown, J.S., & Duguid, P. (2001). Knowledge and organization: A social-practice perspective. *Organization Science*, 12(2), 198–213. <https://doi.org/10.1287/orsc.12.2.198.10116>
- Dekker, S. (2011). *Drift into failure: From hunting broken components to understanding complex systems*. Ashgate.
- Dekker, S. (2014). *The field guide to understanding human error* (3rd ed.). Ashgate.
- El Asri, H., Tsiakalos, S., & Anakkar, K.T. (2025). Driving aviation performance with knowledge management metrics and key performance indicators: A quantitative analysis. *Journal of Knowledge Management Practice*, 25(2). <https://doi.org/10.62477/jkmp.v25i2.514>
- Grant, R.M. (1996, Winter). Toward a knowledge-based theory of the firm. *Strategic Management Journal*, 17(Winter Special Issue), 109–122.

- Grant, R.M. (2013). Reflections on knowledge-based approaches to the organization of production. *Journal of Management & Governance*, 17(3), 541–558.
- Hislop, D., Bosua, R., & Helms, R. (2018). *Knowledge management in organizations: A critical introduction* (4th ed.). Oxford University Press.
- Hollnagel, E. (2014). *Safety–I and Safety–II: The past and future of safety management*. Ashgate.
- International Civil Aviation Organization. (2018). *Annex 19 to the Convention on International Civil Aviation: Safety management* (2nd ed.). ICAO.
- Kıvanç, E., Tuzkaya, G., & Vayvay, Ö. (2025). Safety management system and risk-based approach in aviation maintenance: A systematic literature review. *Safety Science*, 184, Article 106755. <https://doi.org/10.1016/j.ssci.2024.106755>
- Leveson, N. (2011). *Engineering a safer world: Systems thinking applied to safety*. MIT Press.
- Nonaka, I. (1994). A dynamic theory of organizational knowledge creation. *Organization Science*, 5(1), 14–37. <https://doi.org/10.1287/orsc.5.1.14>
- Nonaka, I., & Takeuchi, H. (1995). *The knowledge-creating company*. Oxford University Press.
- Reason, J. (1990). *Human error*. Cambridge University Press.
- Reason, J. (1997). *Managing the risks of organizational accidents*. Ashgate.
- Roe, E., & Schulman, P.R. (2008). *High reliability management: Operating on the edge*. Stanford University Press.
- Stein, E.W., & Zwass, V. (1995). Actualizing organizational memory with information systems. *Information Systems Research*, 6(2), 85–117.
- Stroeve, S., Smeltink, J., & Kirwan, B. (2022). Assessing and advancing safety management in aviation. *Safety*. <https://doi.org/10.3390/safety8020020>
- Tsiakalos, S., & El Asri, H. (2025). Innovating aviation resilience: The role of emerging technologies in the Middle Eastern air transport industry. *Journal of Contingencies and Crisis Management*, 33. <https://doi.org/10.1111/1468-5973.70097>
- Tyagi, A., Tripathi, R., & Bouarfa, S. (2023). Learning from past in the aircraft maintenance industry: An empirical evaluation in the safety management framework. *Heliyon*, 9. <https://doi.org/10.1016/j.heliyon.2023.e21620>
- Uwayezu, E., & El Asri, H. (2023). *Knowledge Transfer and Succession Planning in the Aviation Industry*. Communications of the IBIMA.
- Vrahimi, V., & Mancera, M. (2019). *Knowledge management in a high-risk organisation: A case study on an aviation school* (Master's thesis, BUSN49 20191). Department of Business Administration, Lund University. <https://lup.lub.lu.se/lup/download?func=downloadFile&recordOId=8980935&fileOId=8980939>
- Walsh, J.P., & Ungson, G.R. (1991). Organizational memory. *Academy of Management Review*, 16(1), 57–91.
- Weick, K.E., & Sutcliffe, K.M. (2001). *Managing the unexpected: Assuring high performance in an age of complexity*. Jossey-Bass.
- Weick, K.E., Sutcliffe, K.M., & Obstfeld, D. (2005). Organizing and the process of sensemaking. *Organization Science*, 16(4), 409–421. <https://doi.org/10.1287/orsc.1050.0133>
- Woods, D.D. (2015). Four concepts for resilience and the implications for the future of resilience engineering. *Reliability Engineering & System Safety*, 141, 5–9.