

Rethinking the Role of Non-Compliance in Complex Operational Systems

- Compliance, Variation, and Adaptive Safety

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Abstract

Safety-critical industries traditionally operate on the assumption that procedural compliance ensures safe performance and that unsafe outcomes emerge primarily when individuals deviate from approved instructions, standards, or regulatory boundaries. This logic—compliance equals safety; deviation equals risk—underpins investigation frameworks, accountability structures, enforcement models, and training philosophies in domains such as aviation, healthcare, nuclear energy, rail, maritime operations, and chemical process industries.

However, field investigations and observational studies increasingly demonstrate that real-world work rarely matches formal expectations. Variability in context, operational conditions, system states, timing, resource availability, and environmental constraints means that procedures describe how work is imagined, not how it is performed. Operators routinely adapt, modify, or bypass procedural steps to maintain operational continuity and preserve safety. In a recently published thesis, Ankersø and Nielsen refer to this form of deliberate, safety-oriented deviation as Selective Intentional Non-Compliance (SINC): purposeful departures from procedure undertaken to maintain functional performance under conditions where strict execution is insufficient or unsafe.

This paper examines the tension between compliance-based safety models and the role of adaptive performance in preventing hazardous outcomes. Using the conceptual framework illustrated in Figure 1, we propose the identification of a previously unacknowledged region: the SINC-Avoid zone, the operational space where strict procedural compliance can contribute to hazard escalation while adaptive deviation preserves system safety. Recognising, training for, and governing this capability is essential if safety management systems are to remain effective within complex, variable, and dynamic environments.

Keywords: compliance; non-compliance; resilience engineering; Work-as-Imagined; Work-as-Done; just culture; SINC; SINC-Avoid.

1. Introduction

Across safety-critical industries, the prevailing organisational safety logic has long rested on a simple and appealing assumption: if those performing operational tasks adhere to documented procedures, regulatory requirements, and established safety management frameworks, then safe outcomes will follow. Conversely, when accidents or near-misses occur, they are widely assumed to result from departures from these established rules. Procedures are treated not only as instructions for execution, but as the primary defence against hazardous system states. Compliance becomes synonymous with safety, and deviation is treated as prima facie evidence of error, carelessness, or negligence. The structure of most contemporary investigative frameworks, assurance processes, and accountability systems reflects this foundational belief.

This assumption rests on a particular understanding of how work occurs—one that treats it as linear, predictable, and fully specifiable in advance. Procedures, checklists, and standards are typically written from the perspective of planners and engineers working with what Hollnagel has termed Work-as-Imagined (WAI): a conceptual model of ideal task execution derived from documented system knowledge, past experience, risk assessment, and regulatory expectations. In practice, however, the operational environment is rarely as stable, orderly, or predictable as this model implies. Variability in context, equipment condition, available resources, competing demands, environmental constraints, and emergent events means that tasks unfold under conditions that differ materially from those assumed by their designers.

This divergence between how work is expected to occur and how it must be performed in practice is not an occasional anomaly: it is an intrinsic and unavoidable property of sociotechnical systems. Operators routinely encounter gaps, ambiguities, constraints, and practical challenges that are absent from procedural representations. To keep the system functioning, they adjust, interpret, prioritise, and sometimes invent local solutions that allow operations to continue safely. These adaptations—often subtle, improvised, or tacit—are not expressions of disregard for procedure but manifestations of the expertise, resilience, and flexibility upon which real-world system performance depends.

Until recently, much of this adaptive behaviour existed outside formal recognition and, in some cases, outside organisational legitimacy. Empirical evidence from aviation, rail, nuclear energy, and healthcare demonstrates that a significant proportion of everyday safe performance depends not on rote compliance, but on the capacity of skilled operators to judge when, how, and to what extent procedures can be applied, adapted, or set aside in response to unfolding conditions. In this paper we adopt the categorisation of Ankersø and Nielsen for this phenomenon as Selective Intentional Non-Compliance (SINC): a purposeful, context-sensitive deviation from written instruction, undertaken not to save effort or time, but to maintain or restore system safety and operational integrity when procedural execution alone would be insufficient.

Recognising the role of SINC challenges deeply embedded assumptions within compliance-based safety models. It raises uncomfortable questions: Can a strictly compliant action be unsafe? Are there circumstances in which deviation is the safer choice? And if so, how should organisations train, govern, and learn from such behaviour? These questions are not theoretical. They reflect a persistent tension that emerges whenever rigid procedural control meets the inherent variability of complex systems.

The difficulty is that current regulatory and managerial discourse offers little conceptual space for acknowledging or legitimising the type of adaptive decision-making on which system resilience often depends. The dominant narrative remains binary: compliance is aligned with safety and professionalism, whereas deviation—intentional or otherwise—signals risk, liability, and blame. As a result, operators who make contextually appropriate decisions to deviate from procedure in order to prevent emerging harm frequently do so invisibly and without institutional support. In post-incident review, such decisions may be judged harshly—not because they were unsafe at the time, but because deviation exists outside formal doctrine.

To move beyond this paradox, we must interrogate the underlying assumptions linking compliance to safety and reconsider the role of adaptation in hazardous work. The aim of this paper is not to diminish the importance of procedures or to suggest that unstructured autonomy is desirable. Rather, it is to provide a conceptual and practical framework for

understanding when, why, and how adaptive non-compliance functions as a legitimate and necessary component of system safety. By making this space visible—and naming it—we create the conditions under which it can be examined, trained, governed, and ethically defended.

2. Work-as-Imagined, Work-as-Prescribed, and Work-as-Done

Understanding the gap between procedural compliance and actual operational behaviour requires a distinction between three complementary but fundamentally different representations of work: Work-as-Imagined, Work-as-Prescribed, and Work-as-Done. Although these concepts are sometimes used interchangeably in organisational discourse, each reflects a distinct perspective and plays a unique role in shaping how safety is understood, enacted, and evaluated.

Work-as-Imagined (WAI) represents how planners, regulators, designers, and managers conceive that work should occur. It exists primarily in policy documents, management assumptions, risk assessments, and training doctrine. This representation is inherently abstract: it simplifies, idealises, and generalises tasks in order to make them legible enough to document and control. WAI assumes a degree of predictability in both work conditions and system behaviour. Variability is acknowledged only insofar as it can be predicted and codified. As a result, WAI tends to reflect the system from the perspective of those who construct oversight frameworks, rather than those who perform work under real conditions.

From this imagined state flows Work-as-Prescribed (WAP) — the formal expression of how work is to be carried out. WAP is manifested in procedural documents, checklists, standard operating procedures, regulatory standards, and certification frameworks. While WAI defines intent, WAP defines method. It specifies the order of actions, required checks, mandatory constraints, tolerances, and decision thresholds. It carries legal weight; compliance with WAP is often treated as evidence of due diligence, and deviation from it as evidence of fault. Importantly, WAP frequently assumes that the procedure is sufficient for the range of conditions under which work will be performed.

In contrast, Work-as-Done (WAD) reflects how work actually unfolds in practice. WAD contains the lived reality of operational performance: the subtle adjustments, improvisations, delays, anticipations, shortcuts, and contextual judgements that allow work to continue under conditions of uncertainty, pressure, or change. WAD is not inherently disorderly or undisciplined; rather, it is adaptive. Operators modulate their behaviour in response to what they perceive, not what documents assume. This ability to adjust performance in real time is not a deviation from safety — in many cases, it is the mechanism that sustains it.

The divergence between WAI, WAP, and WAD is not a problem to be eliminated but a structural feature of complex sociotechnical systems. Variability in work is inevitable because variability in the world is unavoidable. What changes, often imperceptibly, are system constraints: weather shifts, equipment degrades, software behaves unexpectedly, priorities compete, communication signals degrade, and interdependencies propagate subtle changes across the system. Under these conditions, rigid adherence to WAP may be inefficient, impractical, or even dangerous. Consequently, operators develop informal rules, tacit heuristics, and situational adaptations that enable them to maintain functionality despite discrepancies between prescribed and real conditions.

This divergence becomes problematic when organisational oversight assumes alignment between WAP and WAD. When procedures are treated as a perfect representation of operational reality, any deviation is likely to be seen through a moral rather than systemic lens—as a behavioural failure rather than a functional adjustment. This creates a latent tension: the system depends on adaptive behaviour to operate effectively, yet formal governance structures often prohibit acknowledging or supporting such behaviour.

Contemporary safety research increasingly recognises that resilience does not emerge solely from the elimination of variability but from the capacity to monitor, anticipate, and adjust to changing demands. The gap between Work-as-Imagined, Work-as-Prescribed, and Work-as-Done is the space where that adaptive capability lives. Whether organisations choose to treat this space as a source of vulnerability or as a wellspring of resilience significantly influences how incidents are interpreted, how training is designed, and how accountability is assigned. The remainder of this paper argues that failure to acknowledge this space—and the adaptive actions that occur within it—creates conditions in which operators may be forced to choose between compliance and safety. Understanding that tension requires examining the nature and role of intentional deviation, to which we now turn.

3. Selective Intentional Non-Compliance (SINC)

As the gap between prescribed work and real operational demands has become increasingly visible across safety-critical sectors, a more nuanced understanding of deviation has begun to emerge. Not all departures from procedure are careless, reckless, or unmotivated. In many cases, deviation is deliberate, considered, and grounded in experienced judgement. We refer to this form of behaviour as Selective Intentional Non-Compliance (SINC): a purposeful choice to deviate from written instruction or constraint because, in the moment of action, strict adherence is assessed as impractical, obstructive, or unsafe.

The recent empirical study in commercial aviation provides an initial quantitative anchor for this argument. Ankersø and Nielsen examined Selective Intentional Non-Compliance (SINC), defining it as a “purposeful and deliberate deviation from policies or procedures when a flight crew’s judgement is that deviating from a procedure could improve flight safety,” and explicitly distinguished it from efficiency-driven Procedural Intentional Non-Compliance (PINC).

In a survey of 39 European line pilots, 43% reported intentionally deviating from standard operating procedures occasionally or frequently in the previous 12 months, and nearly one-third of those deviations were explicitly motivated by safety concerns rather than convenience, commercial pressure, or habit. These findings support the claim that safety-driven deviation is neither rare nor marginal, and that SINC describes a recognisable category of behaviour in everyday operations rather than a purely theoretical construct.

Taken together, these results narrow the conceptual space that this paper treats more broadly across sectors: they show that what we describe as SINC is already observable, nameable, and reportable in at least one high-reliability domain.

SINC represents a category of behaviour that has historically remained largely invisible in formal discourse, yet is widely present in practice. It is not the same as shortcutting for convenience, ignoring rules, or engaging in what Reason termed routine violations. Rather, SINC is characterised by a safety-oriented rationale. The operator is not attempting to bypass safety controls but to preserve them under conditions not anticipated by the original design.

At its core, SINC reflects the reality that procedures are cognitive anchors, not universal solutions. They cannot fully account for the nuanced interplay of disturbances, constraints, emergent hazards, and time-critical dynamics that define complex sociotechnical work environments. When faced with a mismatch between prescribed action and situational reality, experienced practitioners do not default to rigid execution. Instead, they assess the affordances and vulnerabilities of the situation and choose a course of action aligned with maintaining system integrity.

Illustrative examples can be found across domains. In aviation, flight crews may adjust approach configurations or braking schedules when runway or atmospheric conditions differ significantly from those assumed in standard procedures. In clinical medicine, practitioners may alter dosage timing or bypass approval pathways to prevent irreversible deterioration in a rapidly changing patient condition. In chemical operations, a technician may temporarily override an interlock to prevent a runaway reaction when the procedural response sequence is too slow to match the developing hazard. These decisions are not acts of defiance; they are acts of stewardship.

Despite its functional importance, SINC sits uncomfortably within traditional models of safety governance. Compliance frameworks, regulatory structures, and courtroom logic assume that rule adherence is the only defensible pathway to safe performance. Under such frameworks, SINC has no legitimate standing. If an adverse outcome follows, even if the deviation prevented a different and potentially more serious outcome, the operator's actions may be evaluated in hindsight against procedural expectations rather than situational necessity.

This tension places practitioners in a precarious ethical position. When faced with conditions in which strict compliance with procedure may contribute to escalating risk, they may be forced to choose between two forms of vulnerability: the vulnerability of the system if the rule is followed, and their own vulnerability if it is not. In such circumstances, SINC becomes not only an operational decision but a moral negotiation.

Research into resilience and adaptive capacity suggests that systems which rely exclusively on procedural compliance are brittle. They function effectively only under conditions anticipated by designers and regulators. When variation exceeds these boundaries, they degrade rapidly. In contrast, systems that recognise and support adaptive non-compliance are more capable of absorbing unexpected disturbances, reorganising around constraints, and maintaining function under degraded conditions.

The existence and ubiquity of SINC challenges the long-standing binary categorisation of operational behaviour as compliant versus non-compliant. Instead, it suggests a spectrum ranging from rigid adherence to reckless improvisation, with a central region where intentional adaptive deviation is both necessary and beneficial. Clarifying and legitimising this region requires new conceptual tools—not least a clearer vocabulary and visual framing. It is this transition point, where compliance and safety diverge, that introduces the critical concept explored in the next section: the SINC-Avoid zone, where deviation is not merely adaptive but essential to prevent harm.

4. The SINC-Avoid Paradox and the Operational Boundary of Compliance

The recognition of SINC exposes a deeper structural tension at the heart of modern safety governance. If deviation can sometimes preserve safety, then procedural compliance cannot be assumed to be universally protective. This tension becomes most visible at the edges of operational practice—where existing rules, assumptions, and procedural models no longer match the emerging conditions of work. It is at this boundary that a paradox emerges: there are circumstances in which compliance increases risk, and deviation reduces it. This condition forms the basis of what we term the SINC-Avoid paradox.

In conventional safety logic, the relationship between compliance and safety is monotonic: more compliance equates to less risk. Deviation is understood as a movement away from acceptable performance and toward hazard. However, empirical investigations and retrospective analyses of both accidents and successful recoveries suggest that the relationship is not linear. In certain scenarios, adherence to prescribed actions may escalate hazard potential because the procedure is misaligned with context, assumes conditions that are no longer present, or requires a timing sequence incompatible with emerging system dynamics. In these cases, deviation is not a drift away from safety—it is the only viable path back toward it.

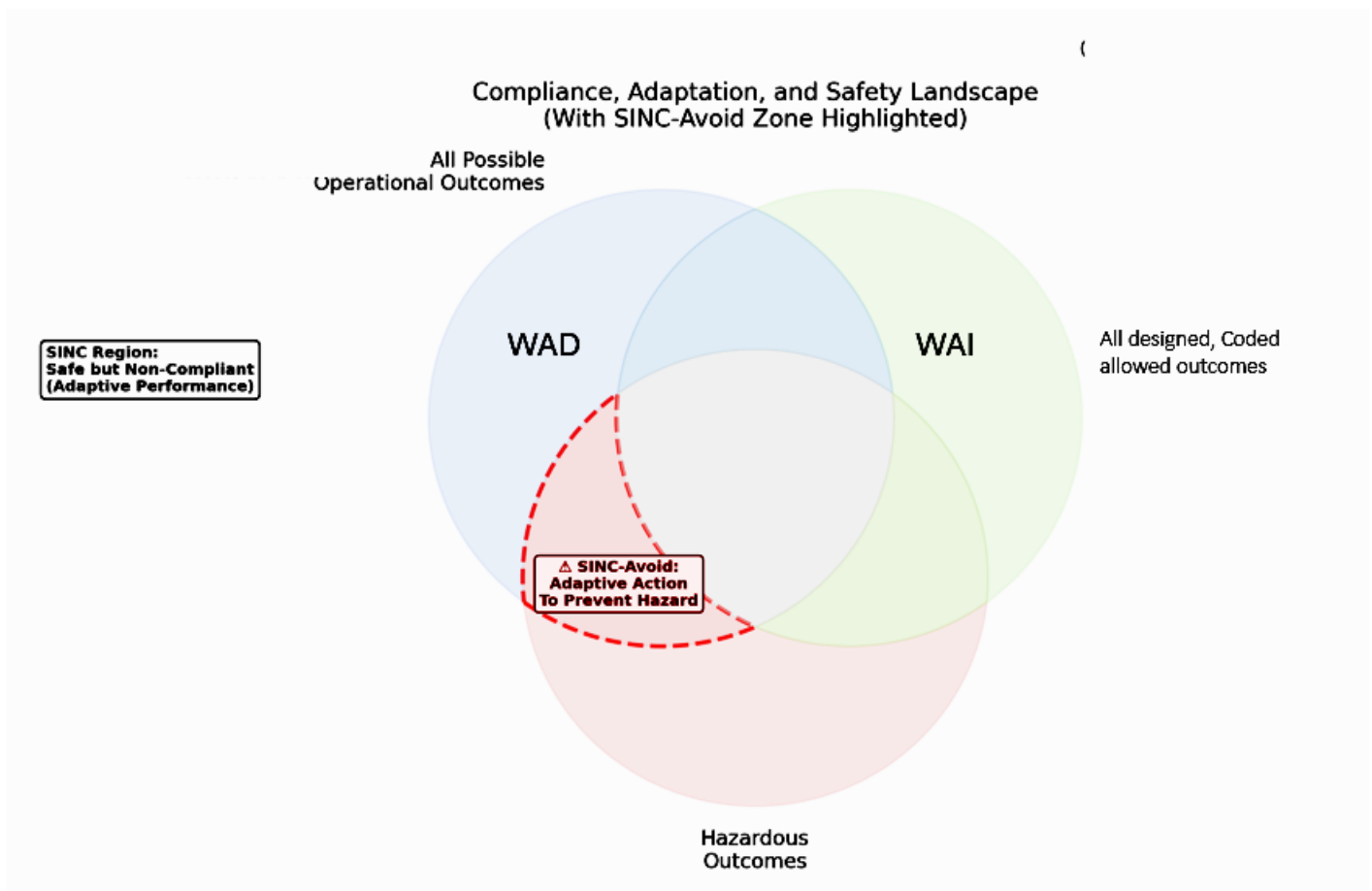


Figure 1 – A conceptual model of the Venn triad of how work is actually done

The conceptual model developed earlier in this paper and illustrated in Figure 1 helps make this paradox visible. The three intersecting domains—Work-as-Done, Work-as-Imagined, and Hazardous Outcomes—create a nuanced operational landscape. Most organisational assumptions are located in the region where Work-as-Imagined overlaps with safe areas of Work-as-Done: the space where compliance functions as intended. The existence of safe practices outside Work-as-Imagined is typically acknowledged only reluctantly and usually retrospectively. Yet the most critical region for system resilience exists where work is being performed (Work-as-Done), a hazard is present or forming (Hazardous Outcomes), and the prescribed procedural pathway (Work-as-Imagined) is no longer sufficient or appropriate.

This small but consequential overlap represents the operational decision space in which strict compliance may lead to unsafe outcomes, and intentional deviation becomes necessary to prevent harm. We refer to this as the SINC-Avoid zone. It is not an expression of discretionary behaviour for convenience; it is the region of last responsible action. Operators arrive here not because they disregard the procedure, but because they have recognised—through experience, situational cues, or system feedback—that continued adherence risks system degradation or irreversible harm. In such a moment, action requires not only technical competence but ethical and professional courage.

Despite its importance, the SINC-Avoid zone remains largely invisible to organisational discourse because it sits outside the formal logic of compliance. Safety management systems rarely acknowledge that such a region exists, and training programmes seldom address how to recognise or navigate it. Instead, operators learn to manage this paradox tacitly, through experience, mentorship, informal knowledge transfer, and cultural signalling. As a result, the ability to act effectively in this zone becomes a feature of individual expertise rather than a supported organisational capability.

The aviation data reported by Ankersø and Nielsen further illuminates the SINC-Avoid region as a lived, rather than hypothetical, operational space. Among pilots who reported occasional or frequent deviations, 53% stated that they had encountered situations in which strict adherence to procedures would have *reduced* safety margins, and all respondents agreed that flight crews should have the flexibility to deviate from SOPs when this is judged necessary for safety. At the same time, only around one-third of those safety-driven deviations had ever been formally reported into the safety management system, with the remainder either unreported or forgotten. This pattern is exactly what the SINC-Avoid concept predicts: operators repeatedly find themselves in a bounded decision space where procedural compliance is recognised as hazardous and adaptive deviation is chosen to protect the system, yet those decisions largely remain invisible to organisational memory, investigation, and regulation.

Their analysis also warns that if these situationally justified deviations are neither recognised nor harvested as learning, they risk drifting over time into habitual, convenience-based violations (PINC), blurring the boundary between resilience and erosive normalisation of deviance.

The failure to explicitly recognise the SINC-Avoid zone creates a systemic blind spot. When deviations within this space prevent a negative outcome, they are rarely documented or analysed. When they fail, they are frequently judged through the retrospective lens of procedural expectations rather than the prospective reality of operational constraints. This

disconnect risks producing organisational narratives that appear internally consistent but fundamentally misrepresent the conditions of work. Over time, such narratives can distort learning, erode just culture, and undermine trust between front-line practitioners and regulatory or organisational leadership.

The central argument emerging from this analysis is that the boundary between compliance and adaptation must itself become an explicit component of safety management. Rather than treating non-compliant action only as failure, organisations must develop the conceptual, ethical, and operational frameworks needed to distinguish reckless violation from necessary adaptive action. Only then can learning extend beyond the binary of compliance versus deviation and begin to address the real mechanisms by which safety is maintained under variable and uncertain conditions. The following section outlines design principles for such a framework.

5. Design Principles for a Resilience-Based Compliance Framework

If organisations are to bridge the divide between formal procedural systems and the adaptive behaviours required for safe performance in complex environments, then compliance itself must evolve. The objective is not to weaken regulatory discipline or dilute accountability, but to create a framework in which compliance and adaptation are integrated rather than positioned as opposing forces. A resilience-based compliance framework recognises that safety emerges not only from the prevention of deviation but also from the capacity to adjust performance when reality diverges from assumptions. This reframing requires a fundamental shift in how procedures are conceived, how operators are prepared, and how performance is interpreted.

The first principle is explicit acknowledgement. Resilient systems recognise that variability in work is natural, expected, and necessary. Rather than designing procedures as inflexible scripts, organisations should acknowledge that prescriptive content represents one possible safe pathway rather than the only one. This acknowledgement ought to be reflected in procedural language, operational doctrine, and regulatory expectations. When organisations openly recognise the existence and legitimacy of the SINC-Avoid zone, they reduce the cognitive and ethical burden on operators who must make difficult decisions in time-compressed, uncertain conditions.

The second principle is prioritising functional intent over literal compliance. Procedures often specify both what must be achieved and how it should be done. In routine operations these aspects align effectively. Under non-normal conditions, however, adherence to method may obstruct adherence to purpose. A resilience-based compliance philosophy distinguishes between these layers, elevating operational intent as the primary anchor for decision-making. Such an approach gives operators permission—and responsibility—to prioritise safe outcomes when procedural pathways no longer align with situational demands.

The third principle concerns training for adaptive competence. In many industries, training programmes focus heavily on procedural memorisation and error avoidance. While these skills remain essential, they are insufficient for environments characterised by uncertainty, emergent hazards, or real-time trade-offs. Training should therefore include the cultivation of situational awareness, pattern recognition, risk-based judgement, and uncertainty navigation. Scenarios involving degraded procedural relevance should be incorporated into simulation and assessment environments, allowing operators to practise recognising the operational boundary

where adaptation becomes necessary. Such training not only builds capability, but also normalises the discussion of adaptive action within organisational culture.

A fourth principle is documenting and learning from adaptive performance. Traditional incident reporting systems prioritise deviations that result in failure. Near-miss reporting may capture additional signal but seldom captures successful adaptive performance—particularly when such performance required non-compliance. A resilience-based framework expands the learning boundary to include positive deviance: occasions where operators navigated the SINC-Avoid zone successfully. This form of reporting provides a data source for procedural improvement, hazard anticipation, and organisational understanding of real operational variability.

The fifth principle is graded evaluation and accountability. Current compliance models tend toward binary categorisation: an action is either compliant or non-compliant. Such simplification is incompatible with the complexity of real-world decision-making. Accountability models must reflect proportionality, intent, context, and necessity. Under a resilience-based system, reckless or self-serving deviation remains unacceptable. However, actions taken in good faith to prevent harm—particularly in the presence of misaligned or insufficient procedural guidance—are evaluated based on their safety rationale rather than their degree of procedural alignment. This requires an evolution in investigation methodology, just culture frameworks, and legal doctrine.

Finally, a resilience-based framework must include continuous updating of prescriptive knowledge based on lived experience. As adaptive strategies emerge, organisations should seek to understand whether they indicate skill, necessity, or systemic deficiency. Some adaptive practices may reveal gaps in procedural design; others may reflect conditions not yet fully understood by system architects. Incorporating this feedback into procedural revision, hazard models, and training curricula ensures that Work-as-Imagined evolves in response to Work-as-Done rather than remaining a static artefact disconnected from operational reality.

Taken together, these principles reposition compliance as a dynamic relationship between formal guidance and adaptive expertise. Rather than forcing a rigid separation between rule-following and rule-breaking, a resilience-based compliance framework treats adaptation as a legitimate component of safe performance and provides system structures that support—rather than punish—the operator when navigating the boundary between compliance and necessity. The next section examines the organisational, regulatory, and ethical challenges involved in implementing such a framework.

6. Organisational and Regulatory Challenges in Implementing Adaptive Compliance, and the Cultural, Legal, and Ethical Implications of the SINC-Avoid Framework

Recognising the legitimacy of adaptive non-compliance and integrating the SINC-Avoid concept into operational governance is not simply a technical revision to safety doctrine. It represents a deeper shift with far-reaching organisational, regulatory, cultural, legal, and ethical consequences. Systems built on a compliance-dominant worldview must confront a reality in which adherence to instruction is no longer an infallible surrogate for safe action. This transition is challenging precisely because the assumptions it disrupts are foundational: they shape how organisations define accountability, assess performance, assign blame, design training, and signal professional identity.

At the organisational level, the primary challenge lies in reconciling two competing safety logics. The first is the control model, in which procedures constrain behaviour to prevent variability and error. The second is the resilience model, in which variability is both inevitable and necessary, and where safety depends on the capacity of practitioners to adjust performance in response to changing system conditions. Organisations accustomed to measuring safety by procedural adherence may struggle to acknowledge that safe work sometimes depends on sanctioned deviation. This creates tension in governance structures, performance indicators, and management expectations. Metrics that valorise compliance but ignore context can inadvertently penalise precisely the behaviours that maintain safety under real-world conditions.

Regulatory environments introduce an additional layer of complexity. Many jurisdictions anchor legal protection, certification, and defensibility in demonstrable compliance with approved procedures and standards. Regulatory systems are not inherently hostile to adaptation, but they rely on predictability, auditability, and demonstrable due diligence. Introducing adaptive compliance into such frameworks raises difficult questions: under what circumstances is deviation allowable, who defines those conditions, and how can such decisions be reviewed without the distortions of hindsight? Without clear regulatory scaffolding, organisations may fear that acknowledging the necessity of adaptive deviation exposes them to legal vulnerability rather than operational improvement.

Cultural barriers may be even more significant than structural ones. Many high-risk domains have deeply internalised narratives linking professionalism with procedural obedience. Training curricula, certification bodies, and supervisory cultures often reinforce the belief that “good practitioners follow the procedure,” and that deviation signals incompetence, arrogance, or indiscipline. Even when adaptation occurs routinely, it often remains unspoken, informal, and rhetorically denied. The introduction of the SINC-Avoid framework directly challenges these identity narratives. It shifts the definition of expertise away from rote procedural execution and toward skilled contextual judgement. Such a shift may provoke resistance—not because the argument lacks merit, but because it threatens established hierarchies of legitimacy.

The legal and ethical implications extend further. At present, many legal frameworks treat compliance as the primary defence against liability and non-compliance as prima facie evidence of wrongdoing. However, if deviation can be necessary to prevent harm, then the ethical justification for blame based solely on non-compliance weakens considerably. This reframes accountability from rule-based evaluation to intent- and context-based evaluation, requiring investigators, regulators, and courts to consider whether the practitioner’s decision was reasonable under the circumstances, not merely whether it aligned with written instruction. Such a transition aligns more closely with established ethical traditions in medicine, law, and emergency response, but represents a significant departure from conventional industrial safety jurisprudence.

Another ethical dimension arises in relation to organisational transparency. If practitioners are expected to navigate the SINC-Avoid boundary, it becomes ethically untenable for organisations to silently depend on adaptive behaviour while publicly insisting that procedures are always sufficient. This gap—often left unacknowledged—places practitioners in a position where their duty of care may conflict with organisational messaging. Closing this gap requires organisations to recognise and formally legitimise the possibility that safety may require deviation, and to create mechanisms through which such decisions can be discussed, taught, reviewed, and improved.

Finally, the shift toward adaptive compliance requires a transformation in how learning is conducted. Post-event review processes, such as investigations or audits, must evolve from determining whether rules were followed to understanding why adaptation was required, whether the system supported it appropriately, and whether procedural or regulatory frameworks require revision. The goal is not to normalise arbitrary deviation, but to institutionalise a structured pathway through which the lessons of real-world adaptation can improve Work-as-Imagined and Work-as-Prescribed.

In sum, implementing the SINC-Avoid framework is not merely a procedural update—it is an invitation to re-examine the moral architecture of safety governance. It challenges organisations, regulators, and professions to move beyond a simplistic binary of compliance and violation, and toward a more mature understanding in which safety is recognised as an emergent property of interaction between procedures, operational realities, and adaptive human judgement.

7. Discussion and Synthesis

The analysis presented in this paper highlights a critical tension in the way modern safety-critical systems conceptualise and manage operational performance. Safety has long been framed as a property achieved through the faithful execution of predefined procedures and standards. This framing has influenced regulation, organisational culture, training doctrine, and post-event accountability for decades. Yet the realities explored in the preceding sections demonstrate that such a framing, while administratively convenient, is incomplete. It captures only one dimension of safe practice—the idealised and designed one. It does not adequately represent the dynamic, context-sensitive, and adaptive nature of real work, particularly when systems enter non-normal states or encounter variation beyond their design envelope.

Across industries, the divergence between Work-as-Imagined, Work-as-Prescribed, and Work-as-Done reveals that adaptation is not merely common—it is intrinsic and indispensable. Operators routinely adjust procedures to align with evolving conditions, resolve ambiguities, or compensate for system brittleness. These adaptive behaviours have historically remained largely invisible because they occur in the shadow of procedural doctrine. Yet they provide one of the most important mechanisms through which systems avoid degradation or failure. In acknowledging SINC, we make visible a dimension of work that has always existed but rarely been named.

The aviation study by Ankersø and Nielsen illustrates how this triadic view of behaviour—compliant actions that support safety, intentional deviations that enhance safety, and reckless or convenience-driven violations that degrade safety—can be operationalised empirically. Their survey not only demonstrates that intentional non-compliance is common but also shows that approximately one-third of such deviations are safety-motivated SINC, that over half of the pilots have faced situations where procedures would have reduced safety margins, and that safety-driven deviations are systematically under-reported in organisational data. This combination—prevalent SINC, recognised necessity for procedural flexibility, and a structural reporting blind spot—offers a concrete example of how the SINC-Avoid zone manifests within a specific safety-critical domain. It also suggests a research agenda for other sectors: to distinguish safety-driven adaptation from erosion of discipline to document how often practitioners are pushed into the SINC-Avoid region, and to redesign safety management systems so that successful adaptive non-compliance becomes a routine source of learning rather than a hidden, individual risk.

The identification of the SINC-Avoid zone adds a further layer of nuance. It clarifies that deviation is not uniformly risky nor uniformly benign; rather, its meaning is context dependent. There are moments when compliance aligns with safety, and moments when compliance compromises it. The SINC-Avoid zone represents a narrow but consequential operational boundary in which the practitioner must choose between procedural fidelity and contextual safety. This boundary is uncomfortable to acknowledge because it challenges the historical certainty that procedures can fully capture the path to safety. Yet field evidence repeatedly demonstrates that in complex systems, safety emerges not from rigidity but from responsiveness.

The synthesis of this work therefore challenges the implicit binary—compliance as safe, deviation as unsafe—that has shaped much of contemporary safety governance. Instead, it suggests a three-part conceptualisation: compliant actions that support safety; intentional deviations that enhance safety (captured by SINC and SINC-Avoid); and reckless or uninformed deviations that degrade safety and remain subject to control and accountability mechanisms. Recognising this structure reframes deviation from a moral failure to a potential form of expertise. It moves accountability discourse away from “Did they follow the rule?” toward “Was the decision reasonable given the operational context, system state, and available information?”

This reframing also clarifies why traditional reforms—such as increasing the number of procedures, tightening compliance expectations, or adding punitive oversight—often fail to produce meaningful safety improvements. Such measures attempt to constrain variability rather than steward it. They assume that greater prescriptiveness yields greater control, even though operational reality demonstrates that excessive procedural rigidity can reduce adaptability, erode operator autonomy, and increase brittleness under non-normal conditions. The resilience-based compliance framework proposed in this work seeks to correct that imbalance by treating adaptation not as a departure from safety, but as one of its essential mechanisms.

Importantly, this synthesis does not advocate unstructured autonomy or procedural abandonment. Procedures remain essential scaffolding, providing direction, coordination, repeatability, and boundaries. The discussion instead argues for a shift in how they are interpreted and governed. Rather than being treated as immutable scripts, procedures should function as informed guidance—structures that shape action but do not prohibit adaptive judgement when circumstances demand it.

The integration of adaptation into formal doctrine also enables new forms of organisational learning. When adaptive actions are acknowledged, discussed, and analysed—rather than hidden or punished—they become valuable feedback loops. They reveal where procedures are incomplete, where assumptions no longer match reality, and where operational variability requires revised design, training, or regulatory support. In this way, the SINC-Avoid framework becomes not only a descriptive model of work, but a mechanism for continuous improvement of Work-as-Imagined and Work-as-Prescribed.

The central proposition, then, is that the future of safety in complex systems lies not in eliminating variability, but in understanding and governing it. To support this shift, organisations and regulators must evolve toward systems that balance prescriptive stability with adaptive flexibility. Doing so requires not only procedural redesign but also cultural, legal, and ethical transformation.

8. Conclusion and Future Directions

This paper has examined the assumptions, structures, and cultural foundations underpinning compliance-based safety frameworks in high-risk domains, and has demonstrated that these frameworks only partially describe how safety is actually created and sustained in real operational environments. The conventional belief that procedural adherence is synonymous with safe performance, and that deviations are inherently undesirable or dangerous, has shaped policy, regulation, training, and incident investigation for decades. Yet the evidence and arguments presented suggest that such a view is incomplete. In practice, safety is often achieved not through strict compliance alone but through the adaptive capacity of practitioners to respond intelligently when reality diverges from what was anticipated, modelled, or prescribed.

Central to this reframing is the recognition of Selective Intentional Non-Compliance—a form of deliberate, context-sensitive deviation undertaken to maintain operational integrity when procedures are insufficient or misaligned with the evolving state of the system. Within this behavioural spectrum lies a particularly critical subset: the SINC-Avoid zone, identified in the conceptual model presented in this paper. This zone represents those rare but consequential circumstances in which compliance may escalate hazard and deviation may prevent harm. While historically overlooked, denied, or treated as an error category, this zone reflects one of the system's most important resilience mechanisms.

Recognising the existence and necessity of the SINC-Avoid zone requires organisations and regulators to reconsider how they conceptualise procedural control, accountability, training, and learning. It challenges the binary separation of compliant versus non-compliant behaviour and invites a more mature understanding of operational decision-making—one that evaluates actions in relation to situational demands, system state, and underlying safety intent rather than solely by reference to documentary alignment. Such a shift reframes deviation from a moral or procedural failure to a potential expression of expertise, stewardship, and responsibility.

The transition toward a resilience-based compliance framework is neither trivial nor merely procedural. It requires regulatory systems capable of supporting context-based interpretation rather than rule-bounded judgement. It requires training systems that develop adaptive competence alongside procedural fluency. It requires accountability frameworks that distinguish reckless violation from necessary operational agility. And critically, it requires cultural foundations grounded in trust—trust that practitioners intend to act safely, trust that the system will support contextually appropriate judgement, and trust that deviation in service of safety will not automatically trigger blame.

Future research should explore several avenues. First, empirical studies are needed to document how adaptive non-compliance manifests across industries and operational cultures, identifying patterns, triggers, thresholds, and enabling conditions. Second, methodological advances are required to support investigations that can evaluate the reasonableness of decisions made within the SINC-Avoid zone rather than defaulting to procedural hindsight. Third, policy research is needed to determine how regulatory structures can legitimise and support adaptive judgement without creating ambiguity or eroding system accountability. Finally, there is an opportunity to develop tools, simulations, and professional development frameworks designed explicitly to teach the recognition and navigation of the compliance–adaptation boundary.

The argument advanced here is not that procedures are unnecessary, nor that deviation is desirable, nor that autonomy should supersede structure. Rather, it is that safety in complex sociotechnical systems cannot rely on compliance alone. Safety emerges from the dynamic interplay of guidance, expertise, adaptation, and context. Procedures provide stability; practitioners provide resilience. A safety system capable of acknowledging both is better aligned with the realities of modern operation and better equipped to protect those who rely on it.

By integrating adaptive capacity into the core logic of safety management—rather than treating it as a tolerated anomaly—we move toward a model of safety that is not only technically robust, but ethically honest, operationally realistic, and capable of learning from the very behaviours that keep systems functioning when conditions become uncertain, unpredictable, or unexpected.

9. References

- Amalberti, R. (2001). The paradoxes of ultra-safe systems: The challenges of moving from one paradigm to another. *Safety Science*, 37(2–3), 109–126. [https://doi.org/10.1016/S0925-7535\(00\)00045-2](https://doi.org/10.1016/S0925-7535(00)00045-2)
- Amalberti, R. (2013). The paradoxes of almost totally safe transportation systems. *Safety Science*, 53, 133–142. <https://doi.org/10.1016/j.ssci.2011.12.018>
- Ankersø, K. F., & Nielsen, I. M. (2025). *Selective Intentional Non-Compliance (SINC) in Commercial Aviation: A Study of Pilot Decision Making in Safety-Critical Situations*. MSc Thesis, Norwegian University of Science and Technology (NTNU), Trondheim.
- Dekker, S. (2011). *Drift into Failure: From Hunting Broken Components to Understanding Complex Systems*. Ashgate.
- Dekker, S. (2012). *Just Culture: Balancing Safety and Accountability* (2nd ed.). Ashgate.
- Dekker, S. (2014). *The Field Guide to Understanding ‘Human Error’* (3rd ed.). CRC Press.
- Hollnagel, E. (2012). *FRAM: The Functional Resonance Analysis Method: Modelling Complex Socio-Technical Systems*. Ashgate.
- Hollnagel, E. (2014). *Safety-I and Safety-II: The Past and Future of Safety Management*. Ashgate.
- Hollnagel, E., Woods, D. D., & Leveson, N. (Eds.). (2006). *Resilience Engineering: Concepts and Precepts*. Ashgate.
- Rasmussen, J. (1997). Risk management in a dynamic society: A modelling problem. *Safety Science*, 27(2–3), 183–213. [https://doi.org/10.1016/S0925-7535\(97\)00052-0](https://doi.org/10.1016/S0925-7535(97)00052-0)
- Rasmussen, J., Pejtersen, A. M., & Goodstein, L. P. (1994). *Cognitive Systems Engineering*. Wiley.
- Reason, J. (1990). *Human Error*. Cambridge University Press.
- Reason, J. (1997). *Managing the Risks of Organizational Accidents*. Ashgate.
- Woods, D. D. (2006). How to design a safety organization: Test the structure against failure modes. In E. Hollnagel, D. D. Woods, & N. Leveson (Eds.), *Resilience Engineering: Concepts and Precepts* (pp. 335–345). Ashgate.
- Woods, D. D., & Branlat, M. (2011). Basic patterns in how adaptive systems fail. In E. Hollnagel, P. Paries, D. D. Woods, & J. Wreathall (Eds.), *Resilience Engineering in Practice: A Guidebook* (pp. 127–144). Ashgate.