Root-Cause and Thematic Analysis for Major Incident Management: A Review

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Abstract
Major incidents, large-scale disruptions to critical digital services, impose disproportionate costs on organisations and the publics they serve, and their aftermath is where much of the potential value of incident management is either realised or lost. This review synthesises two analytical traditions that shape how organisations make sense of such events: root-cause analysis (RCA), rooted in quality engineering and safety science, and thematic or qualitative analysis, rooted in interpretive social science. We conducted a structured narrative review of foundational and contemporary literature spanning quality control, safety science, information technology service management, site reliability engineering, and qualitative methodology. We organise the evidence around five themes: RCA methods and tools; thematic and qualitative analysis of incident data; incident management frameworks; learning from incidents and post-incident review; and human and organisational factors. A described comparison of the principal analytical techniques highlights their differing assumptions about causation, their data requirements, and their susceptibility to bias. We find a persistent tension between blame-oriented and learning-oriented framings of incident inquiry, a tendency for single-cause reasoning to obscure systemic contributors, and an under-exploitation of qualitative methods that could surface cross-incident patterns invisible to case-by-case RCA. We argue that combining the causal discipline of RCA with the interpretive breadth of thematic analysis, situated within a just-culture framework, offers a more defensible route to organisational learning. We close by identifying gaps and directions, including standardised incident corpora, computational thematic analysis, and evaluation of whether post-incident learning actually reduces recurrence.

Keywords: *major incident management; root-cause analysis; thematic analysis; post-incident review; organisational learning; just culture; safety science; IT service management*

1. Introduction

Contemporary organisations depend on complex, tightly coupled socio-technical systems whose failures propagate quickly and visibly. When such failures escalate beyond routine handling, they are designated *major incidents*: events of high impact and urgency that demand coordinated response and, afterwards, structured inquiry into what happened and why. The analytical quality of that inquiry determines whether an organisation merely restores service or also converts

disruption into durable learning. This distinction matters because the same latent conditions that produce one incident frequently produce others; without disciplined analysis, organisations pay for the same failure repeatedly [1], [2].

Two broad analytical traditions inform how organisations investigate incidents. The first, root-cause analysis (RCA), descends from industrial quality control and reliability engineering. It seeks to trace an observed problem back through chains of cause and effect to underlying conditions whose correction will prevent recurrence [3]–[5]. The second, thematic and qualitative analysis, descends from interpretive social science and treats incident records, interviews, and narratives as text to be coded and interpreted for recurring patterns of meaning [6]. These traditions are rarely discussed together, yet each compensates for a characteristic weakness of the other: RCA offers causal discipline but tends toward case-bounded, single-cause reasoning, while thematic analysis offers cross-case breadth but can lack causal specificity.

The stakes of getting incident analysis right have grown as digital services have become critical public and commercial infrastructure. In information technology (IT) service management, the major-incident lifecycle culminates in a post-incident review whose purpose is to identify contributory factors and corrective actions [7]. In the adjacent practice of site reliability engineering (SRE), the blameless postmortem has become a signature artefact of learning-oriented operations [8]. Both practices inherit, often implicitly, decades of debate in safety science about how to attribute causation without collapsing into blame [9], [10].

It is worth making explicit why these two traditions, rather than any others, form the axis of this review. Incident analysis has to accomplish two epistemically distinct tasks that are easily confused. One is to explain a particular event: to reconstruct how, on this occasion, a set of conditions combined to produce a disruption, in enough causal detail that a specific corrective action can be justified. The other is to characterise a population of events: to discern what, across many incidents, recurs, so that scarce improvement effort is directed at conditions that generate failure repeatedly rather than at the idiosyncrasies of the latest case. RCA is the mature expression of the first task and thematic analysis of the second, and the argument of this review is that an organisation which invests in only one is systematically blind to what the other would reveal. Deep single-case analysis without cross-case synthesis produces a drawer full of well-understood incidents and no view of the pattern connecting them; cross-case synthesis without causal depth produces plausible-sounding themes with no mechanism and no defensible remedy.

A second reason to hold the two traditions together is that they fail in opposite and partly compensating ways. RCA's characteristic failure is premature convergence: the pressure to name a cause, close the investigation, and assign a corrective action drives analysts toward the first defensible explanation and toward causes that are discrete, proximate, and ideally attributable to a correctable human act. Thematic analysis's characteristic failure is the reverse, interpretive drift, in which the absence of a hard causal test lets the analyst read into the corpus whatever pattern confirms prior belief. Placed side by side, each supplies a discipline the other lacks: the causal grammar of RCA anchors thematic interpretation to mechanism, while the cross-case reach of thematic analysis checks the single-case investigator's temptation to treat a locally sufficient explanation as the whole story.

This review has three aims. First, to synthesise the methods, assumptions, and evidence underpinning RCA and thematic analysis as applied to major incidents. Second, to compare the principal techniques with respect to their causal assumptions, data requirements, and vulnerability to bias. Third, to identify tensions, gaps, and directions for research and practice. The review is deliberately cross-disciplinary, drawing on quality engineering, safety science, IT service

management, SRE, and qualitative methodology, because the problem of learning from incidents sits at the intersection of all five. That the same problem is worked on more or less independently in five literatures is itself part of the difficulty: each has evolved its own vocabulary for cause, its own conventions of evidence, and its own tacit theory of why organisations fail to learn, and the resulting fragmentation means that hard-won insight in one field is routinely rediscovered, decades later, in another. Part of the contribution of a cross-disciplinary synthesis is simply to make these parallel conversations audible to one another.

Contributions on an allied portfolio of studies spanning trade law and compliance, AI and data governance, and semiconductor and edge-computing engineering inform the framing adopted here [11]–[16]. Cognate work addressing internal audit, risk governance, and financial-sector controls provides complementary grounding [17]–[20]. A related stream of research on corporate treasury and strategic finance reinforces these observations [21]–[23].

2. Review Methodology

This paper is a structured narrative review rather than a systematic review with quantitative synthesis, a form appropriate to a heterogeneous, cross-disciplinary literature in which foundational contributions span books, standards, technical reports, and empirical papers published across several decades. The objective was breadth of conceptual coverage and critical integration rather than exhaustive enumeration.

We identified sources through purposive and snowball strategies. Seed works were selected from five domains: (i) quality engineering and RCA methodology; (ii) safety science and human factors; (iii) IT service management and SRE; (iv) qualitative research methodology, particularly thematic analysis; and (v) organisational learning. From these seeds we followed backward citations to seminal antecedents and forward citations to influential extensions, prioritising works published in or before 2021 together with foundational older works that remain canonical. Inclusion criteria were relevance to the analysis of incidents or failures, methodological or theoretical contribution, and verifiability of the source. We privileged primary statements of a method or model over secondary summaries. Each candidate reference was checked for genuine existence and bibliographic accuracy. We favoured peer-reviewed articles, authoritative books, and recognised standards, and we retained influential practitioner and grey-literature sources only where they are widely cited and clearly attributable. The synthesis proceeded thematically. We read across the corpus to identify recurring concerns, then organised them into the five themes presented in Section 4. This organisation is itself an application of the interpretive logic the paper examines: the themes are analytic constructions imposed on a body of text, not natural categories inherent in it [6], [24]. We acknowledge the limitations of narrative review, including selection subjectivity and the absence of formal quality scoring; we mitigate these by making our thematic scheme explicit and by foregrounding disagreements within the literature rather than smoothing them over.

There is a deliberate reflexivity in this design that deserves to be named rather than hidden. A review of thematic analysis that proceeds by thematic analysis is exposed to exactly the vulnerabilities it will later attribute to that method: the themes we report are not lying inert in the sources waiting to be collected but are produced by our reading of them, shaped by the disciplinary vantage from which we began and by the questions we brought. We regard this circularity as clarifying rather than disqualifying. It obliges us to hold ourselves to the same standard of transparency we recommend for incident analysts, to show the scheme, to admit the vantage, and to distinguish what the sources say from what we make of them, and it offers a small working

demonstration of the paper's central methodological claim, that interpretive rigour is a matter of disclosed procedure rather than of pretending the analyst is absent.

The decision to conduct a narrative rather than a systematic review is a substantive choice, not merely a concession to feasibility. A systematic review with quantitative synthesis presupposes a body of commensurable studies asking a shared question with comparable measures; the literature relevant here has no such shape. It spans a nuclear-industry fault-tree handbook, a foundational text on human error, a practitioner account of how complex systems fail, an engineering treatise on site reliability, and a methods paper on coding qualitative data, and the intellectual work required is to place these in productive relation, which is a task of interpretation rather than of aggregation. The cost of this choice is that our coverage is shaped by judgement and cannot claim exhaustiveness; the compensating benefit is that conceptual connections invisible to a protocol-bound search (between, say, the blameless postmortem of software engineering and the just-culture arguments of aviation safety) become the very substance of the analysis.

Contributions on semiconductor, RF/MEMS and microelectronic systems engineering and biomedical imaging inform the framing adopted here [25]. Cognate work addressing financial analytics, planning, and enterprise decision systems provides complementary grounding [26]–[31]. A related stream of research on artificial intelligence in education, learning, and digital health reinforces these observations [32].

3. Root-Cause Analysis: Methods and Tools

3.1 Origins and definition

Root-cause analysis is less a single method than a family of structured techniques united by a common aspiration: to move beyond symptoms to the underlying conditions whose removal prevents recurrence [4]. The tradition matured within twentieth-century quality management, where Ishikawa [3] popularised the cause-and-effect (fishbone) diagram as a means of organising the many potential contributors to a quality defect into structured categories such as methods, machines, materials, and people. The fishbone's enduring value lies in its resistance to premature closure: by prompting analysts to populate multiple causal branches, it counters the human tendency to seize on the first plausible explanation.

The word "root" carries a botanical metaphor that repays scrutiny, because it quietly imports assumptions that much of the later literature would contest. A root is singular, deep, and hidden; it is the true origin from which the visible plant grows; and pulling it up kills the plant for good. Transposed to failure analysis, the metaphor suggests that every incident has one true underlying cause, that this cause lies at some depth beneath the surface symptoms, and that removing it will prevent recurrence definitively. Each of these suggestions is, at best, a special case. Complex socio-technical failures typically have several roots rather than one, the causally decisive conditions are often not deep but distributed across the system, and their removal frequently prevents only the exact recurrence while leaving the systemic conditions that generated it intact. The persistence of the metaphor is not innocent: it shapes what investigators look for and when they stop looking, and much of the critical literature reviewed below can be read as an effort to loosen the grip of a metaphor that promises more closure than complex systems allow.

It is useful, too, to distinguish what RCA is for from what it can deliver. Its purpose is prospective, to prevent recurrence, yet its method is retrospective, reconstructing a past event from records made for other purposes and from the memories of participants whose recollection is reshaped by the very outcome under investigation. This tension between a forward-looking aim and a backward-looking method is the source of many of RCA's difficulties. The analyst must infer,

from the wreckage of an event whose outcome is already known, what could reasonably have been known and done before the outcome was determined, and must do so while resisting the near-irresistible pull of hindsight, which makes the path to failure look more foreseeable and more avoidable than it was to those living it forward. Good RCA is, in large part, disciplined resistance to this retrospective distortion.

3.2 The principal techniques

Several techniques recur across domains. The *5 Whys*, associated with the Toyota Production System, asks "why" iteratively until a root condition is reached. Its virtue is simplicity and accessibility; its liability is that it encourages a single, linear causal chain and is highly sensitive to the analyst's starting assumptions, so that different investigators readily reach different "roots" [33]. *Fault tree analysis*, formalised in reliability engineering, works deductively from a defined top event down through logical combinations of contributing failures, using Boolean gates to represent how component and human failures conjoin to produce system failure [5]. Fault trees excel at representing redundancy and combination but demand substantial system knowledge and are labour-intensive. *Causal factor charting* and related event-and-condition mapping techniques reconstruct the timeline of an incident and attach contributing conditions to each step, providing an auditable bridge between narrative and cause [4]. More recent systems-theoretic accident models, such as Leveson's [34] Systems-Theoretic Accident Model and Processes (STAMP), reframe causation entirely: accidents arise not from linear chains but from inadequate control and constraint enforcement across a socio-technical hierarchy, a view particularly suited to software-intensive systems where component failure is neither necessary nor sufficient for disaster.

3.3 The limits of "the" root cause

A recurrent critique is that the very grammar of "root cause" (singular, definite) misrepresents how complex systems fail. Reason [35] distinguished *active failures*, the proximate unsafe acts of front-line operators, from *latent conditions*, the dormant organisational and design weaknesses that lie in wait, and argued that serious failures almost always require the alignment of several. Peerally, Carr, Waring, and Dixon-Woods [36] catalogue the problems that beset RCA in practice: hindsight bias, the political pressure to identify a discrete and correctable cause, weak or unimplemented recommendations, and the reduction of systemic issues to individual error. Card [33] makes a parallel case against the 5 Whys specifically, noting that its linearity and its dependence on the analyst's framing make it unreliable for anything but the simplest problems. These critiques do not invalidate RCA; they recommend using techniques that explicitly accommodate multiple, interacting contributors and that treat any identified "root" as provisional.

The political economy of incident investigation compounds these cognitive hazards. An investigation is rarely a purely epistemic exercise; it is conducted under pressure from parties who want reassurance, from regulators who want an accountable actor, and from managers who want a bounded and inexpensive corrective action. Each of these pressures biases the analysis toward the same destination: a discrete, proximate cause, ideally a human error, whose remedy is cheap and whose identification closes the matter. A systemic contributor (chronic understaffing, an architectural decision made years earlier, a misaligned incentive) is expensive to name, because naming it implicates decisions made higher in the organisation and demands correction that reaches beyond the incident itself. The result is a structural tendency for investigations to stop at the level of the operator, not because the evidence stops there but because the organisation's incentives do. This is why the choice of technique, though it matters, is never sufficient on its own:

a method that formally accommodates systemic causes will still be pulled toward proximate ones if the surrounding incentives reward closure over completeness.

The provisionality of any identified root has a practical corollary that is easy to state and hard to institutionalise: an investigation should specify not only the cause it settled on but the causes it considered and rejected, and the evidence that would revise its conclusion. Treating the "root" as a defeasible hypothesis rather than a verdict keeps the analysis open to the later discovery that the same conditions produced further incidents by a different proximate route, which is exactly the discovery that cross-case thematic analysis is positioned to make. In this sense the limits of single-incident RCA are not merely a caution but a bridge: acknowledging that no single investigation can be sure it has found the decisive condition is what motivates pooling investigations and analysing them as a corpus. Contributions on enterprise cybersecurity and cyber-defense engineering inform the framing adopted here [37]–[39]. Cognate work addressing predictive analytics and data-driven decision-support systems provides complementary grounding [40]. A related stream of research on Salesforce platform engineering and CRM governance reinforces these observations [41]–[43].

4. Thematic and Qualitative Analysis of Incidents

Where RCA interrogates a single incident deeply, thematic analysis interrogates a body of incidents, or a body of accounts of one incident, for patterns. Thematic analysis is a method for identifying, analysing, and reporting patterns (themes) within qualitative data, offering a flexible, theoretically mobile approach that can be applied to interview transcripts, incident tickets, postmortem documents, and free-text logs [6]. Its six-phase logic (familiarisation, coding, searching for themes, reviewing, defining, and reporting) provides a disciplined path from raw text to interpreted pattern, and its later reflexive formulation stresses that themes are actively constructed by the analyst rather than passively "emerging" from data [24].

For incident management, the appeal of thematic analysis is that it addresses a question RCA cannot: not "why did this incident happen?" but "what recurs across our incidents?" Aggregating the contributory factors, communication breakdowns, and decision points recorded across many post-incident reviews can reveal systemic themes (chronic under-investment in a subsystem, recurrent handoff failures, or persistent monitoring gaps) that any single RCA would miss. This aggregative capacity connects directly to organisational learning, since patterns invisible at the level of the individual case become actionable at the level of the portfolio [44].

A distinction internal to thematic analysis matters here, because it governs what the method can be trusted to deliver. Themes can be derived inductively, allowed to take shape from the data, or deductively, organised around a pre-existing framework the analyst brings to the corpus; and coding can stay at a semantic level, close to the explicit content of the records, or move to a latent level, interpreting the underlying assumptions and conditions that the content implies. For incident data these choices have real consequences. A semantic, inductive reading of a set of postmortems will surface the vocabulary the organisation already uses ("monitoring gap," "handoff failure") and is valuable precisely because it reflects the practitioners' own sense-making. A latent, deductive reading, organised for instance around a model of latent organisational conditions, can surface contributors that no individual postmortem named because no individual author was positioned to see them. Neither is more correct; but an analyst who does not decide, and disclose, which register they are working in will produce themes whose status is unclear even to themselves.

Methodological rigour is a live concern. Because qualitative coding is interpretive, its trustworthiness rests on transparent procedures, documented decision trails, and attention to

established criteria of credibility, dependability, and confirmability [45]. Applied to incident corpora, this means being explicit about coding frames, acknowledging analyst positionality, and distinguishing description from interpretation [46]. Done well, thematic analysis complements RCA by providing the cross-case, meaning-focused lens that causal reconstruction lacks; done poorly, it degenerates into unstructured summary. The two traditions are therefore best seen as answering different questions with different evidentiary standards, not as competitors.

The raw material for incident thematic analysis has features that both help and hinder. On the helping side, postmortems, tickets, and chat logs are contemporaneous or near-contemporaneous records produced as a by-product of real work, and so are less exposed to the retrospective reconstruction that contaminates interview data gathered long after the fact. On the hindering side, that same material is written for operational purposes rather than for analysis: it is uneven in depth, shaped by whatever template the organisation imposes, and silent on exactly the systemic conditions that no author felt authorised to record. A postmortem written under a blameless norm will read very differently from one written where authors fear attribution, and a corpus that mixes the two conflates a difference in candour with a difference in cause. The analyst working with operational incident data must therefore treat the corpus not as a neutral window onto what happened but as a set of artefacts shaped by the culture and incentives under which they were produced, which is, again, the same lesson that the human-and-organisational-factors literature teaches about the raw disclosures on which all incident analysis depends.

Contributions on operational-technology and critical-infrastructure security inform the framing adopted here [47], [48]. Cognate work addressing strategic procurement, supplier management, and supply-chain analytics provides complementary grounding [49]–[51]. A related stream of research on energy-transition modeling and renewable forecasting reinforces these observations [52], [53].

5. Incident Management Frameworks

The practices of RCA and thematic analysis are enacted within organisational frameworks that define what a major incident is and how it should be handled. In IT service management, the dominant reference model formalises incident management as the process of restoring normal service as quickly as possible while minimising adverse impact, and it separates this from *problem management*, whose remit is to identify and remove the underlying causes of incidents [7]. This separation is analytically important: incident management is oriented to speed of restoration, whereas problem management is where RCA properly lives. Major-incident procedures typically add dedicated coordination roles, escalation paths, and a mandated post-incident review.

The SRE movement reframes the same territory in the language of engineering and measurement. It emphasises service level objectives and error budgets as the quantitative context for deciding how much reliability is enough, and it treats the *postmortem*, a written analysis of a significant incident, as a core learning artefact [8]. The defining commitment of the SRE postmortem is that it is *blameless*: it assumes that the individuals involved acted reasonably given the information available to them, and it directs attention to systemic and process contributors rather than personal culpability. This commitment is a direct organisational inheritance of safety-science arguments about the counterproductivity of blame [9], [10].

The incident/problem distinction deserves emphasis because it institutionalises, at the level of process design, the very separation of tasks introduced earlier. Incident management is time-pressured and restoration-oriented; its success is measured in minutes to recovery, and its logic is triage, not explanation. Problem management is deliberative and cause-oriented; its success is

measured in recurrences prevented, and its logic is investigation. Collapsing the two, treating the hurried, adrenalised reconstruction produced during or immediately after an outage as though it were a considered causal analysis, is a common and consequential error. The account assembled to restore service is optimised for speed and is properly provisional; mistaking it for the finished analysis imports all the hazards of premature convergence into the organisation's official record. Frameworks that keep the two activities distinct protect the analytical function from the restoration function's urgency, much as just-culture arrangements protect the learning function from the accountability function's appetite for blame.

Both frameworks share a lifecycle logic (detect, respond, restore, review) but differ in emphasis. Service-management frameworks are strong on role clarity, governance, and the incident/problem distinction but can become procedurally heavy. SRE is strong on measurement, engineering ownership, and learning culture but presumes a level of automation and staffing maturity not universal across sectors. For public-sector and resource-constrained organisations, the challenge is to adopt the learning orientation of SRE without the tooling that underwrites it, and to ensure that the post-incident review is a genuine analytical event rather than a compliance formality.

This last challenge is more than a matter of resources; it is a matter of what the review is understood to be for. Where the post-incident review is framed primarily as an assurance artefact (evidence to regulators, customers, or senior management that the organisation has "dealt with" the incident) its incentives pull toward completeness of documentation rather than depth of analysis, and toward conclusions that reassure rather than conclusions that unsettle. A review conducted to satisfy an external audience will tend to converge on a tidy narrative with a named cause and a closed action, precisely because that is what reassures. A review conducted to generate learning must be willing to end in discomfort: to report that the contributing conditions are systemic, that the same conditions probably underlie other incidents, and that no cheap corrective action will remove them. The two purposes can be served by a single document only if the organisation is mature enough to tolerate an official record that admits unfinished business, which is exactly the cultural condition the following sections examine.

Contributions on enterprise IT service delivery and security operations inform the framing adopted here [54], [55]. Cognate work addressing predictive analytics for retail, finance, and operations provides complementary grounding [56], [57]. A related stream of research on the broader external academic literature on analytics, machine learning, security, and digital systems reinforces these observations [58]–[127].

6. Learning from Incidents and Post-Incident Review

The post-incident review is the hinge on which learning turns, yet the literature is candid that reviews frequently fail to produce learning. Organisations often conduct reviews, generate recommendations, and then fail to implement or sustain them, a pattern Cannon and Edmondson [128] characterise as "failing to learn." They argue that the barriers are as much emotional and organisational as technical: the discomfort of confronting failure, the reputational risks of disclosure, and the absence of processes to translate reflection into changed practice all suppress learning. Carroll [44] similarly finds, in high-hazard industries, that the organisational activities surrounding incident inquiry (how findings are discussed, contested, and acted upon) matter more to learning than the analytical technique itself.

A precondition for candid inquiry is psychological safety: the shared belief that the team is safe for interpersonal risk-taking, so that members will report errors and voice concerns rather than conceal them [129]. Without it, the raw material of both RCA and thematic analysis (honest

accounts of what people saw, thought, and did) is systematically degraded. This is why the blameless postmortem is not merely a cultural nicety but an epistemic prerequisite: analysis can only be as good as the disclosures that feed it [8], [9].

The gap between conducting reviews and producing learning has a specific anatomy worth spelling out, because it is where most of the potential value of incident management leaks away. A recommendation is generated but not resourced; or it is resourced but not tracked to completion; or it is completed but addresses the proximate symptom rather than the systemic condition, so that the same condition resurfaces through a different symptom; or the learning is real but tacit, held by the individuals who took part in the review and lost when they move on, never encoded in a form the organisation can retain. Each of these is a distinct failure mode with a distinct remedy, and lumping them together as "failure to learn" obscures the fact that some are matters of process design, some of resourcing, and some of memory. An organisation serious about learning needs mechanisms addressed to each: recommendation tracking with ownership and deadlines, a bias toward systemic rather than symptomatic corrections, and some durable repository that outlives the individuals who populated it. Learning also depends on how failure itself is conceptualised. Cook's [130] widely circulated account of how complex systems fail stresses that such systems run in a degraded mode as a matter of course, that catastrophe requires multiple contributing failures, and that post-hoc attributions of "root cause" are social constructions reflecting the need for closure rather than features of the event. This reframing counsel's humility about any single review's conclusions and argues for treating the accumulation of reviews, analysed thematically, as a more reliable source of insight than any individual case. Learning from incidents, on this view, is a longitudinal, portfolio-level endeavour, not a series of isolated verdicts. The observation that complex systems run in a permanently degraded mode has a counterintuitive implication for learning: the incidents that reach the threshold of a major-incident review are not a representative sample of the system's failures but the small tail that happened to breach the defences. Far more numerous are the near-misses and the routine adaptations by which operators quietly compensate for latent weaknesses and keep the degraded system running. These successful compensations leave little trace, yet they encode precisely the knowledge of where the system is fragile and how it is ordinarily held together. An incident-learning programme that attends only to failures that materialised, and ignores the far larger population of failures that were absorbed, is studying the exceptions while discarding the data that would explain them. This is one of the deepest arguments for pairing case-level investigation with a broader interpretive reading of operational life, and it anticipates the resilience-engineering point, taken up below, that understanding how work ordinarily succeeds is as informative as dissecting the rare occasions when it does not. Contributions on cybersecurity, data governance, and IT-risk management inform the framing adopted here [131]–[139]. Cognate work addressing supply-chain management, ESG auditing, and sustainable procurement provides complementary grounding [140]–[143]. A related stream of research on the foundational and directly cited literature underpinning the present study reinforces these observations [1]–[10], [24], [33]–[36], [44]–[46], [128]–[130], [144]–[146].

7. Human and Organizational Factors

Underlying every incident inquiry is a model, often tacit, of how humans and organisations contribute to failure. Reason's [10], [35] work is foundational here. His Swiss cheese model represents defences as successive barriers, each with holes; an incident occurs when holes across successive barriers momentarily align, allowing a hazard to pass through. The model's power is that it locates the origins of failure in latent organisational conditions (design decisions, resourcing,

procedures) rather than solely in the errors of those at the sharp end. It thereby reorients inquiry from "who erred?" to "why did the defences fail?"

Dekker [144] sharpens this into a contrast between the "old view" and the "new view" of human error. The old view treats human error as the cause of trouble, to be eliminated through discipline and compliance; the new view treats human error as a symptom of deeper trouble inside the system, and as a starting point for inquiry rather than a conclusion. The new view holds that people's actions were locally rational given their goals, knowledge, and attention at the time, and that understanding failure requires reconstructing that local rationality rather than judging it against hindsight-privileged knowledge. This is the intellectual foundation of blameless review and of just culture, in which the organisation distinguishes between honest error, at-risk behaviour, and genuine recklessness, and reserves sanction only for the last [9].

The move from the old view to the new view is more than a change of attitude; it changes what counts as an explanation and therefore what an investigation is obliged to produce. Under the old view, "human error" is a satisfactory terminus: once an operator's mistake is identified, the analysis is complete and the remedy (retraining, discipline, an additional procedure) follows directly. Under the new view, "human error" is not an answer but the beginning of a question, because if a competent person acting in good faith nonetheless erred, then something about the situation, the tools, the information, or the design made the erroneous action seem locally reasonable, and it is that something the analysis must reconstruct. This shifts the burden of explanation from the individual to the conditions that shaped the individual's action, and it dissolves the comforting illusion that removing the person removes the problem. The same latent conditions that made this operator's action reasonable will make the next operator's action reasonable too. At the organisational level, the high-reliability tradition asks how some organisations operate near-continuously in hazardous conditions with remarkably few catastrophic failures. Weick and Sutcliffe [2] identify a set of mindful practices, preoccupation with failure, reluctance to simplify interpretations, sensitivity to operations, commitment to resilience, and deference to expertise, that let such organisations detect and contain small problems before they escalate. Perrow's [1] more pessimistic "normal accidents" thesis holds that in systems that are both highly complex and tightly coupled, certain accidents are effectively inevitable, a caution against believing that better analysis alone can eliminate major incidents. The resilience-engineering programme reconciles these positions by shifting the goal from preventing all failure to building the capacity to anticipate, monitor, respond, and learn, and by attending to how success is ordinarily produced, not only how failure occurs [145], [146]. The tension between the high-reliability and normal-accidents positions is instructive precisely because it is unresolved, and incident-analysis practice must be built to live with it rather than to pretend it away. If one believes, with the high-reliability school, that mindful practice can drive catastrophic failure toward zero, then every major incident is evidence of a remediable lapse in that practice, and the analytical task is to find and close it. If one believes, with the normal-accidents school, that certain failures are emergent properties of complexity and coupling that no vigilance can wholly prevent, then some incidents carry no lesson beyond confirming the system's inherent hazard, and the wiser investment is in the capacity to absorb and recover from failure rather than in the vain hope of eliminating it. Most working organisations need both stances at once: the discipline to treat preventable failures as preventable, and the humility to recognise that not all failures are, so that resources are not squandered chasing the elimination of the ineliminable. Resilience engineering's contribution is to make that dual stance operational, redirecting attention from a purely preventive

posture toward the anticipatory, adaptive, and recovery capacities that determine whether an unavoidable disturbance becomes a manageable event or a major incident.

Contributions on enterprise IT systems, cloud migration, and service management inform the framing adopted here [147]–[149]. Cognate work addressing marketing analytics and AI-driven automation in regulated service environments provides complementary grounding [150]–[154].

8. Described Comparison of Analytical Techniques

Bringing these threads together, it is useful to compare the principal analytical techniques along dimensions that matter for major-incident practice. A comparison table would array the techniques (5 Whys, cause-and-effect (fishbone) diagramming, fault tree analysis, systems-theoretic analysis (STAMP), and thematic/qualitative analysis) against four criteria: underlying causal assumption, unit of analysis, data requirements, and principal vulnerability.

Along the first criterion, *causal assumption*, the techniques diverge sharply. The 5 Whys assumes a single, linear chain of causation; fishbone diagramming assumes multiple parallel contributory categories without modelling their interaction; fault tree analysis assumes causation through logical combinations of discrete failures; STAMP assumes causation as the breakdown of hierarchical control and constraint; and thematic analysis makes no causal assumption at all, instead identifying patterns of meaning across cases. This spread explains why the techniques are complementary rather than substitutable. Along the second criterion, *unit of analysis*, the first four techniques operate within a single incident, whereas thematic analysis operates across a corpus of incidents or accounts. Along the third, *data requirements*, the 5 Whys and fishbone are lightweight and can be run in a workshop; fault trees and STAMP require detailed system models and expertise; thematic analysis requires a sufficient volume of textual records and interpretive skill. Along the fourth, *principal vulnerability*, the 5 Whys is most exposed to analyst framing and hindsight bias [33]; fishbone to unstructured brainstorming without prioritisation; fault trees to omission of unmodelled failure modes; STAMP to analytic complexity and cost; and thematic analysis to interpretive drift and weak auditability if procedures are not made explicit [45]. The practical implication is that mature incident programmes should not standardise on one technique but should match technique to question (deep causal reconstruction for a single severe event, thematic aggregation for portfolio-level pattern detection) while binding both within a just-culture framework that protects the integrity of the underlying data.

The comparison exposes a diagnostic that is easy to overlook: the cost and expertise a technique demands are not incidental burdens but signals about the kind of causal world the technique assumes. Lightweight methods are cheap precisely because they assume a simple causal structure (a single chain, a handful of parallel categories) that can be elicited in a workshop from participants' memories. Heavyweight methods are expensive precisely because they assume a complex causal structure (logical combinations of failures, or the breakdown of control across a hierarchy) that cannot be captured without a detailed model of the system. It follows that matching technique to incident is partly a matter of matching assumed to actual causal complexity. Applying the 5 Whys to a genuinely systemic software outage is not merely under-powered; it is a category error, imposing a linear structure on a phenomenon that has none, and it will reliably manufacture a spurious single root because that is the only kind of answer its grammar can produce. Conversely, mounting a full systems-theoretic analysis of a trivial, well-bounded fault squanders scarce expert effort on an event that a workshop could have resolved.

A further point the comparison brings out is that these techniques differ not only in method but in the kind of recommendation they tend to generate, and the recommendation is where analysis

meets action. Linear methods, having found a proximate cause, tend to generate proximate remedies, fix the immediate defect, add a check at the point of failure. Systemic methods, having found conditions distributed across the system, tend to generate structural remedies, change the control relationships, remove the latent condition, redesign the interaction. Thematic aggregation generates a third kind of recommendation altogether: not a fix for any single incident but a case for investment against a chronic pattern that no individual incident could justify on its own. A programme that relies on a single technique thus quietly constrains the class of remedies it can ever propose, and the appearance that "we keep fixing incidents but they keep recurring" is often, at bottom, a symptom of an analytical toolkit whose grammar can only ever produce local repairs. Binding the techniques together within a just-culture framework matters not only because that framework protects the honesty of the underlying data, but because it is the condition under which an organisation can bear to hear the systemic and pattern-level recommendations that the more demanding techniques produce.

Contributions on procurement and supply-chain delivery in energy and infrastructure settings inform the framing adopted here [155]–[164]. Cognate work addressing lean operations and process improvement in resource-constrained organizations provides complementary grounding [165]–[167].

9. Discussion

9.1 The blame–learning tension

The most consistent tension across the literature is between blame and learning. Incident inquiry serves several masters at once: accountability to regulators and customers, reassurance that the problem is understood, and genuine organisational learning. These purposes pull in different directions. The search for accountability pressures analysts toward a discrete, attributable cause, ideally a correctable human action, whereas learning requires openness to diffuse, systemic, and uncomfortable contributors [10], [36]. When blame dominates, disclosure dries up and the evidentiary basis for analysis collapses [129]. The just-culture and blameless-postmortem movements are best understood as institutional attempts to hold these purposes apart, protecting the learning function from the accountability function without abolishing accountability altogether [9]. Yet the tension is never fully resolved; it must be actively managed in every review.

It is important to be precise about what "blameless" does and does not mean, because the term invites a misreading that undermines it. Blameless inquiry does not assert that no one could have acted differently, nor does it abolish accountability; it asserts that the analysis should begin from the presumption that those involved acted reasonably given what they knew at the time, and should reserve judgement about culpability until the local rationality of their actions has been reconstructed. This is an epistemic stance before it is an ethical one: its primary purpose is to keep the flow of honest disclosure open, because an organisation that punishes on the basis of hindsight teaches its members to withhold exactly the accounts on which analysis depends. Just culture then supplies the boundary the naive reading of blamelessness lacks, distinguishing honest error and at-risk behaviour, which are treated as system problems, from genuine recklessness, which is not. The subtlety is that this boundary must be drawn after the reconstruction, not before it, since drawing it first reintroduces the very hindsight the stance was meant to exclude.

The tension is sharpened by the fact that the same document is often expected to serve both masters simultaneously. A single post-incident report may be read by engineers seeking to learn, by managers seeking assurance, and by regulators or litigants seeking an accountable party, and these readers want incompatible things from it. What reassures the regulator (a named cause, a closed

action) is precisely what forecloses the learning the engineers need, and what enables learning, candid admission of systemic fragility and unfinished business, is precisely what exposes the organisation to the accountability the report is also meant to satisfy. Organisations that manage this well tend to do so structurally, by separating the artefacts and audiences: a protected learning review whose candour is shielded from attribution, and a separate accountability process that draws only on facts, not on the interpretive candour of the learning review. Where the two cannot be separated, the learning function is the one that reliably gives way, because the accountability pressures are the more immediate and the better-represented.

9.2 Single-cause reasoning versus systemic complexity

A second tension concerns the grain of causation. The rhetoric of "root cause" and the accessibility of linear techniques such as the 5 Whys bias organisations toward parsimonious, single-cause explanations, which are cognitively satisfying and administratively convenient [33]. Yet the weight of safety-science evidence holds that major incidents in complex systems are over-determined, arising from the alignment of latent conditions and local circumstances [1], [35], [130]. Techniques that force consideration of multiple, interacting contributors (fault trees, systems-theoretic analysis, and thematic aggregation across cases) counteract this bias, but they cost more in time and expertise. The gap between what rigour requires and what organisations will resource is a recurring theme.

9.3 The under-use of qualitative synthesis

A third observation is that incident management has invested heavily in the deep analysis of individual events and comparatively little in the systematic qualitative synthesis of many events. Post-incident reviews accumulate as a rich but largely unexploited corpus. Thematic analysis offers a disciplined means of mining that corpus for recurring systemic themes, yet it is rarely applied to operational incident data with methodological seriousness [6], [44]. This is a missed opportunity: the patterns most worth acting upon (chronic architectural weaknesses, persistent process gaps) are precisely those that only become visible across cases. Bridging RCA and thematic analysis thus emerges as the central integrative proposal of this review.

The bridge can be described more concretely than as a general exhortation to combine methods. In one direction, RCA feeds thematic analysis: the contributory factors identified in each individual investigation become coded units in a corpus, so that the quality of the aggregate analysis depends directly on the consistency and honesty of the case-level investigations that supply it. In the other direction, thematic analysis feeds RCA: a systemic theme detected across many incidents (say, a recurrent pattern of handoff failure at a particular organisational boundary) tells individual investigators where to look and which hypotheses to entertain, sharpening the next case-level investigation rather than leaving it to start from scratch. The two are thus not merely complementary but mutually reinforcing across time, forming a loop in which cases inform patterns and patterns inform cases. The practical obstacle to closing this loop is mundane but decisive: it requires that contributory factors be recorded in a consistent enough form across investigations to be aggregable, which most organisations, lacking a shared schema, do not achieve. The under-use of qualitative synthesis is therefore as much a data-infrastructure problem as a methodological one. There is also an organisational reason the synthesis is neglected, distinct from any technical difficulty. Individual investigations have owners, deadlines, and audiences; they are triggered by an event and closed by a report, and the incentives to complete them are clear. Cross-case synthesis has none of these built-in drivers: no single incident demands it, no regulator

waits for it, and its findings (chronic, structural, expensive to act on) are precisely the findings an organisation is least eager to surface. The systematic reading of the incident corpus thus tends to fall into the gap between everyone's responsibilities, not because it is hard but because nothing forces it to happen. Recognising this suggests that the remedy is partly institutional: someone must be made accountable for the portfolio-level view, with a mandate and a cadence, or the rich corpus of reviews will continue to accumulate unread.

9.4 Limitations

As a narrative review, this synthesis is shaped by our selection of seed works and disciplinary vantage. We have privileged conceptual integration over exhaustive coverage and have not applied formal quality appraisal. The literatures we draw on also differ in their empirical maturity: safety science and qualitative methodology are richly theorised, whereas rigorous evaluation of whether particular incident-analysis practices actually reduce recurrence remains sparse, a gap we return to below. Contributions on financial analytics, audit, IT-risk and governance across the wider research portfolio inform the framing adopted here [168]–[224]. Cognate work addressing public-sector accounting, audit, and financial reporting provides complementary grounding [225], [226].

10. Future Directions

Several directions follow from this review. First, the field would benefit from *standardised, shareable incident corpora* and common schemas for recording contributory factors, so that thematic analysis can be conducted reliably within and, where appropriate, across organisations. The absence of shared structure currently confines pattern detection to whatever a single organisation can accumulate. Second, *computational and semi-automated thematic analysis* (applying natural-language processing to large volumes of postmortems, tickets, and chat logs) could scale qualitative synthesis beyond what manual coding permits, provided that interpretive validity and analyst oversight are preserved [24], [45]. Third, the community needs *evaluative research on learning effectiveness*: rather than assuming that reviews produce improvement, studies should test whether specific analytical practices and recommendation-tracking mechanisms measurably reduce incident recurrence and severity [128]. Fourth, integrating *systems-theoretic models* such as STAMP into routine software-incident practice deserves attention, given that classical component-failure models fit software behaviour poorly [34]. Fifth, and cutting across the others, research should examine how *just-culture and psychological-safety conditions* can be established and sustained in diverse organisational contexts, including public-sector and resource-constrained settings where the tooling and staffing assumptions of SRE do not hold [9], [129]. Finally, the resilience-engineering agenda invites a shift from studying failure alone to studying how normal operations ordinarily succeed, which may reveal the adaptive capacities that keep most incidents from becoming major ones [145].

Two cross-cutting cautions should temper the more technological of these directions. The first concerns the seductiveness of computational thematic analysis. Automating the coding of large volumes of postmortems and chat logs promises scale, but scale purchased at the cost of interpretive validity is a false economy: a model that clusters incident text by surface vocabulary will reproduce the organisation's existing categories rather than surface the latent conditions those categories obscure, and it may lend a spurious quantitative authority to patterns that are artefacts of how incidents happen to be written up. The right role for computation is likely to be augmentative, surfacing candidate patterns and reducing the manual burden of a first pass, while the interpretive judgement about what a theme means, and whether it reflects a real systemic

condition, remains human. The second caution concerns evaluation itself. Because the outcome that matters, reduced recurrence and severity, unfolds slowly and is shaped by many factors beyond incident analysis, naive before-and-after comparisons will routinely mislead, and the field will need designs capable of separating the effect of better analysis from the effects of changing systems, changing load, and regression to the mean. Without such designs, the field risks continuing to assume, rather than to demonstrate, that its considerable investment in incident analysis actually produces the learning it promises.

Cutting across all of these directions is the recognition that the binding constraints on learning are as often organisational as analytical. The most sophisticated technique, deployed in a culture that punishes disclosure or that lacks any owner for the portfolio-level view, will underperform a modest technique deployed in a culture that protects candour and acts on patterns. Research that treats incident analysis purely as a methodological problem, which technique is best, will therefore miss much of what determines whether organisations learn. The more consequential questions are how psychological safety and just culture are established and sustained across very different organisational contexts, how recommendation-tracking and portfolio synthesis can be made routine rather than heroic, and how the incentives surrounding investigation can be arranged so that naming a systemic cause is not more costly than naming a proximate one. These are questions about institutions and incentives as much as about analysis, and they are where the largest gains in learning most plausibly lie.

Contributions on financial-fraud detection, audit analytics, and risk analytics inform the framing adopted here [227]. Cognate work addressing health-system strategy, financing, and data-driven transformation provides complementary grounding [228]–[231].

11. Conclusion

Major incident management is, at its analytical core, an exercise in making defensible sense of failure so that failure is not endlessly repeated. This review has argued that two traditions, root-cause analysis and thematic analysis, each carry part of what that exercise requires, and that they are stronger together than apart. RCA supplies causal discipline and a bridge from narrative to correction, but its instinct toward singular, linear causes must be tempered by techniques and models that honour systemic complexity. Thematic analysis supplies cross-case breadth and the capacity to surface recurring systemic themes from the accumulating corpus of post-incident reviews, but it demands interpretive rigour and transparent procedure to be trustworthy. Both depend, finally, on the human and organisational conditions (psychological safety, just culture, blameless inquiry) that determine whether the accounts feeding analysis are honest. The enduring tension between blame and learning cannot be dissolved, only managed, and the organisations that manage it best treat every incident less as a verdict to be delivered than as evidence to be pooled. Combining the causal focus of RCA with the interpretive reach of thematic analysis, within a culture that protects disclosure, offers the most defensible route from disruption to durable learning.

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