E-ISSN: 3108-4192

APSSHS

Academic Publications of Social Sciences and Humanities Studies
2025, Volume 5, Issue 1, Page No: 81-89
Available online at: https://apsshs.com/

Journal of Applied Organizational Systems and Behavior

Organizational Fragility Under Persistent Over-Optimization and Reduced Operational Slack

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Abstract

Organizations routinely pursue efficiency by reducing inventories, spare capacity, discretionary time, staffing buffers, and duplicative coordination. These practices can improve performance under prevailing operating assumptions, yet their cumulative effects may also narrow the options available when those assumptions fail. This Original Conceptual Theory Article develops a proposed Theory of Over-Optimized Fragility to explain how persistent optimization may convert otherwise rational efficiency practices into a source of organizational vulnerability when adaptive options are progressively depleted or misaligned. The theory distinguishes operational slack from indiscriminate redundancy and treats resilience as a process involving disturbance absorption, response, recovery, and reconfiguration rather than a single stable organizational attribute. It proposes two central mechanisms: behavioral brittleness, defined as narrowing of the enacted response repertoire, and coordination compression, defined as reduction in the temporal, informational, relational, and decision space available for collective adaptation. These mechanisms are theorized to interact with dependency concentration, network complexity, disruption stage, and resource fungibility to amplify vulnerability. The article further proposes adaptive slack as selectively preserved or recoverable option capacity whose value depends on type, location, timing, and fit with disruption conditions. The resulting propositions emphasize persistence, cross-domain depletion, configurational fit, and stage-sensitive moderation rather than a universal efficiency-resilience trade-off. The theory is non-empirical and requires longitudinal, multilevel, network, and disruption-centered testing before any causal, prescriptive, or implementation conclusions are warranted.

Keywords: The fragility of over-optimized organizations, Slack and resilience, Efficiency gains and behavioral brittleness, Coordination breakdown under disruption, Theoretical propositions, Designing for adaptive slack

How to cite this article: El Idrissi F, Bennani S, Benali Y, Ben Ali A. Organizational Fragility Under Persistent Over-Optimization and Reduced Operational Slack. J Appl Organ Syst Behav. 2025;5(1):81-9. https://doi.org/10.51847/Z4zHlWsZcW

Received: 08 September 2025; **Revised:** 22 October 2025; **Accepted:** 24 Octoer 2025
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Introduction

Organizations often improve efficiency by tightening capacity, reducing inventories, standardizing routines, concentrating suppliers, shortening planning cycles, and minimizing resources that appear idle under normal conditions. Such practices are not inherently dysfunctional. The conceptual problem arises when optimization becomes persistent across several domains and progressively removes the options that would permit adaptation when operating assumptions fail. Research on organizational response to adversity shows that crisis response and resilience involve dynamic processes of preparation, adjustment, and recovery rather than a single static organizational property [1]. At the same time, organizational resilience remains heterogeneous in definition and measurement, making it risky to treat any one buffer, recovery metric, or observed performance outcome as equivalent to resilience itself [2]. This ambiguity leaves an important theoretical gap between

efficiency-oriented design choices made before disruption and the organizational capacity to respond once conditions depart from expectations.

Post-disruption operations research likewise shows that major shocks expose assumptions embedded in supply-chain architectures, planning systems, and operating models [3]. Yet exposure to disruption does not by itself establish fragility. Resilience can be represented through different loss and recovery dimensions, including initial impact, maximum degradation, and cumulative loss, and these dimensions need not respond identically to the same operational strategy [4]. The implication is that organizational fragility should not be defined merely as poor performance after a shock. In this article, fragility is proposed as a condition in which deviations from prevailing operating assumptions produce disproportionate impairment, propagation, or recovery difficulty relative to the initiating disturbance.

The role of slack further complicates simple efficiency-versus-resilience narratives. Evidence from manufacturers affected by COVID-19 policy measures indicates that operational slack can buffer adverse valuation responses under specific conditions, while the strength of that relationship depends on operational characteristics such as labor intensity [5]. Such evidence suggests that slack may matter, but it does not establish that more slack is always better, that all slack types are substitutable, or that slack alone generates resilience. The relevant theoretical question is therefore not whether organizations should be efficient or buffered, but how persistent optimization changes the portfolio of adaptive options available across time, resources, routines, decision rights, and interorganizational relationships.

This article develops the proposed Theory of Over-Optimized Fragility (TOF), an original non-empirical theory explaining how sustained optimization pressure may create vulnerability through cumulative adaptive-option depletion. The theory introduces behavioral brittleness and coordination compression as proposed mechanisms linking depleted options to disruption sensitivity, while treating dependency structure, complexity, disruption stage, and resource fungibility as boundary conditions. Its contribution is not to claim that efficiency causes fragility, but to specify when repeated optimization may narrow adaptability enough for otherwise manageable disturbances to become disproportionately consequential.

Theoretical foundations of slack and resilience

The theoretical foundation of TOF begins by separating resilience from the resources that may support it. Business and management research contains several resilience traditions, including adaptation, recovery, robustness, and organizational response to adversity, each emphasizing different processes and levels of analysis [6]. Accordingly, resilience is better treated here as a family of capacities and processes than as a synonym for reserve resources. This distinction also prevents operational slack from being treated as a validated resilience measure. Slack may provide options, but whether those options become useful depends on where they reside, whether they can be mobilized, and what kind of disruption the organization faces.

A second distinction concerns robustness, resilience, and realignment. Global value-chain research differentiates robustness, which emphasizes maintaining function under disturbance, from resilience, which concerns recovery, and realignment, which involves changing the configuration itself when prior arrangements are no longer adequate [7]. These differences matter because an organization may possess enough buffer to absorb a disturbance yet lack the authority, information, or relational capacity to reconfigure. TOF therefore treats adaptive capacity as multidimensional and rejects the assumption that preserving the pre-disruption system is always the relevant objective.

Slack is similarly heterogeneous. Longitudinal research on strategic change indicates that excess employees can support organizational change, but its value is contingent on other resources rather than universally beneficial [8]. This suggests that human-resource slack can create discretionary capacity without guaranteeing successful adaptation. At another level, research on slack time shows that uncommitted time changes effort allocation and coordination opportunities in innovation work, again indicating that temporal slack has value only through how it is used [9]. These findings support a broader conceptualization of operational slack as resource, temporal, capacity, inventory, relational, or decision latitude that can absorb variance or support reconfiguration.

TOF therefore proposes adaptive slack as a narrower construct: selectively preserved or recoverable option capacity that can be redeployed when actual conditions diverge materially from the assumptions under which an operating system was optimized. This is an original synthesis rather than an established measure. Its value is expected to depend on fungibility, location, timing, and organizational authority. The evidence supports the plausibility of heterogeneous slack resources, but it does not establish a universal optimum or a single causal path from slack to resilience.

Efficiency gains and behavioral brittleness

Efficiency improvements can coexist with resilience, which is essential for bounding the theory. Evidence on lean and resilient supply-chain practices indicates that the two can be complementary rather than mutually exclusive [10]. TOF therefore does not define high efficiency, lean management, standardization, or low inventory as fragility in themselves. The proposed problem is persistent optimization that repeatedly removes alternative courses of action without preserving compensating

mechanisms. Under stable conditions, such arrangements may continue to deliver strong performance, making the erosion of adaptability difficult to observe until the environment changes.

The first proposed mechanism is behavioral brittleness: progressive narrowing of the enacted response repertoire as routines, decision rules, staffing patterns, and task allocations become increasingly optimized around recurrent conditions. Research on routine rigidity shows that established routines may persist even when changed circumstances make previously rational practices less appropriate [11]. This evidence supports the possibility of adaptive narrowing, but behavioral brittleness as defined here is broader and remains proposed. It concerns not only reluctance to change routines but also the loss of feasible alternatives because time, skills, discretion, or buffers have been systematically removed.

Inventory provides a concrete illustration of this logic without establishing a universal rule. Quasi-experimental evidence from firms exposed to armed conflict shows that inventory decisions can materially shape operating exposure under severe uncertainty [12]. The implication is not that high inventory is inherently resilient, but that removing a buffer changes the organization's ability to absorb deviations between expected and actual flows. Similar logic may apply to spare capacity, cross-training, discretionary time, or alternative sourcing, although those extensions require separate testing rather than direct inference from inventory evidence.

Behavioral brittleness is also reversible in principle. Qualitative research on resilience learning shows that organizations can build and adapt routines through learning before, during, and after non-routine events [13]. Learning therefore represents a countermechanism: it can expand the response repertoire even when established routines are strong. TOF accordingly predicts brittleness only when optimization removes options faster than learning, experimentation, and reconfiguration recreate them. The construct is thus dynamic and conditional, not a claim that efficient organizations inevitably become rigid.

Coordination breakdown under disruption

A disruption becomes an organizational coordination problem when multiple actors must recognize changed conditions, interpret their implications, exchange information, reallocate resources, and alter interdependent activities under time pressure. Network research shows that local disturbances can propagate through interdependencies while proactive and reactive adaptations change the trajectory of disruption [14]. This supports treating coordination as more than communication quality: response depends on how quickly connected actors can detect, interpret, and modify interdependent arrangements. TOF proposes coordination compression as the reduction in temporal, informational, relational, and decision space available for those activities.

Decision time is particularly important because responsiveness has value only relative to the disturbance being faced. Analytical and empirically calibrated research on demand jumps shows that the value of supply-chain responsiveness depends on demand uncertainty and relevant lead-time structures [15]. An organization may therefore appear efficient while possessing response options that activate too slowly to matter, or it may hold substantial slack in a form that cannot be redeployed where the disturbance occurs. Coordination compression is proposed to arise when persistent optimization simultaneously shortens time margins, centralizes authority, reduces redundant information channels, or eliminates locally accessible alternatives.

Evidence from severe COVID-19 disruption further indicates that continuity and resilience techniques differ in effectiveness when disruption exceeds the assumptions built into preemptive risk mitigation [16]. This reinforces a stage- and context-sensitive interpretation: planning is useful, but no pre-disruption design can be assumed to handle every shock. In TOF, coordination breakdown therefore reflects a mismatch between the demands of the disruption and the remaining capacity for diagnosis, escalation, resource movement, and collective reconfiguration rather than a generic failure of managerial competence.

The proposed coordination-compression mechanism also separates formal capacity from enacted adaptability. An organization may retain documented contingency plans, nominal authority structures, or technically available resources while lacking sufficient time or cross-boundary access to mobilize them during an unfolding event. Conversely, apparently redundant channels may become functional alternatives when primary coordination routes fail. The theory therefore treats coordination capacity as relational and temporal as well as structural. Direct empirical measurement would need to distinguish information availability from information use, formal decision rights from effective authority, and nominal resource access from resources that can actually be redirected within the disruption's relevant response window.

Table 1 organizes the evidence, constructs, relationships, uncertainties, and boundary conditions required for definitions, constructs, and conceptual boundaries for organizational fragility under persistent over-optimization and reduced operational slack.

Table 1. Definitions, constructs, and conceptual boundaries for Organizational Fragility Under Persistent Over-Optimization and Reduced Operational Slack.

Construct or component	Definition	Problem addressed	Distinction from adjacent concepts	Proposed role	Uncertainty	Boundary statement

Organizational resilience	Capacity or process of absorbing, responding to, recovering from, or adapting to adversity	Prevents post-shock performance from being treated as one construct	Broader than any single buffer or recovery metric	Outcome family and theoretical boundary	Measures and levels vary	No single resilience measure is assumed universal
Robustness	Ability to maintain function despite disturbance	Separates preservation from recovery	Not identical to recovery or reconfiguration	Comparison construct	Depends on disruption and design	Maintaining the prior configuration may be insufficient
Operational slack	Resource, temporal, capacity, inventory, relational, or decision latitude beyond immediate requirements	Identifies potentially mobilizable options	Neither waste nor resilience by definition	Literature-anchored umbrella construct	Utility depends on form and context	More slack is not presumed better
Adaptive slack — proposed	Selectively preserved or recoverable option capacity deployable when assumptions fail	Connects slack to adaptation rather than surplus alone	Narrower than generic operational slack	Proposed moderator and design principle	Requires direct operationalization	No validated optimum or threshold is claimed
Flexibility	Ability to shift activities, resources, or configurations	Addresses changing demands and disruptions	Differs from static reserve capacity	Potential adaptive option	Value is time- and context-dependent	Flexibility may be unusable if activated too late
Persistent over-optimization — proposed	Sustained removal or tightening of options around a prevailing operating model	Explains cumulative option depletion	Not equivalent to efficiency itself	Proposed antecedent	Persistence and domain breadth require measurement	Efficient organizations are not presumed fragile
Behavioral brittleness — proposed	Narrowing of the enacted response repertoire	Explains reduced behavioral adaptability	Broader than routine rigidity alone	Proposed mediator	Direct empirical measure is absent	Standardization does not automatically imply brittleness
Coordination compression — proposed	Reduced time, information, relational capacity, or authority for coordinated adaptation	Explains collective response difficulty	Not equivalent to poor communication	Proposed mediator	Multilevel measurement is required	Breakdown is conditional on disruption demands
Organizational fragility — proposed	Disproportionate impairment, propagation, or recovery difficulty when operating assumptions fail	Defines TOF's focal outcome	Not ordinary inefficiency or low performance	Proposed dependent construct	Requires validation against rival measures	No causal status or universal metric is claimed

Vulnerability amplification

Reduced slack does not necessarily make a disturbance consequential. Fragility emerges only when depleted adaptive options interact with structures that magnify exposure, restrict substitution, or slow recovery. Supply-network evidence illustrates why this amplification cannot be represented as a simple linear effect. Complexity can simultaneously increase exposure to disruption and provide alternative pathways for adaptation, depending on its form and location [17]. TOF therefore treats complexity as a boundary condition rather than an intrinsic source of fragility. Dense interdependence may propagate disturbances, whereas diversified pathways may also provide alternative routes when primary connections fail.

Concentration produces a similarly conditional pattern. Evidence on supplier and customer concentration indicates that dependency structures can have different implications during disruption and restoration rather than exerting a uniformly negative effect [18]. This stage sensitivity matters for TOF because an arrangement optimized for coordination efficiency under normal conditions may initially improve visibility or bargaining power while simultaneously narrowing substitution opportunities when a critical dependency fails. The proposed concept of vulnerability amplification consequently refers to the enlargement of disruption consequences when depleted adaptive options interact with dependency architecture, not to dependency concentration itself.

Information capability can reduce some forms of vulnerability without eliminating the organizational problem. Digital supply-chain twins, for example, can support visibility, scenario analysis, and disruption-risk assessment [19]. Yet descriptive visibility is distinct from the authority and capacity required to act on what becomes visible. An organization may identify a bottleneck accurately while lacking alternative suppliers, available employees, inventory, decision time, or permission to reallocate resources. Technological capability therefore cannot be treated as equivalent to substantive adaptability.

TOF proposes that vulnerability amplification occurs when three conditions coincide: a disturbance exceeds assumptions embedded in the prevailing operating model; relevant adaptive options have been depleted or cannot be mobilized; and interdependencies transmit the resulting mismatch beyond its initial location. The magnitude of amplification should remain conditional on disruption novelty, network structure, dependency concentration, resource fungibility, prior experience, and response stage. These relationships are conceptually plausible and consistent with the selected evidence, but vulnerability amplification has not been empirically validated as a general nonlinear organization-level mechanism.

Proposed theory of over-optimized fragility

The proposed Theory of Over-Optimized Fragility integrates the preceding domains around one central argument: persistent optimization may become organizationally consequential when repeated improvements remove or misalign several forms of adaptive option capacity at once. Process flexibility and inventory can substitute for or complement one another in robustness design, demonstrating that resilience-relevant capacity need not reside in a single resource category [20]. TOF extends this configurational insight beyond supply-chain design by proposing that temporal, human, relational, decision, and structural options can likewise form an adaptive portfolio whose usefulness depends on disturbance requirements.

Figure 1 presents the original conceptual synthesis for theory of over-optimized fragility, showing how the article's principal constructs, mechanisms, uncertainties, and decision boundaries are connected.

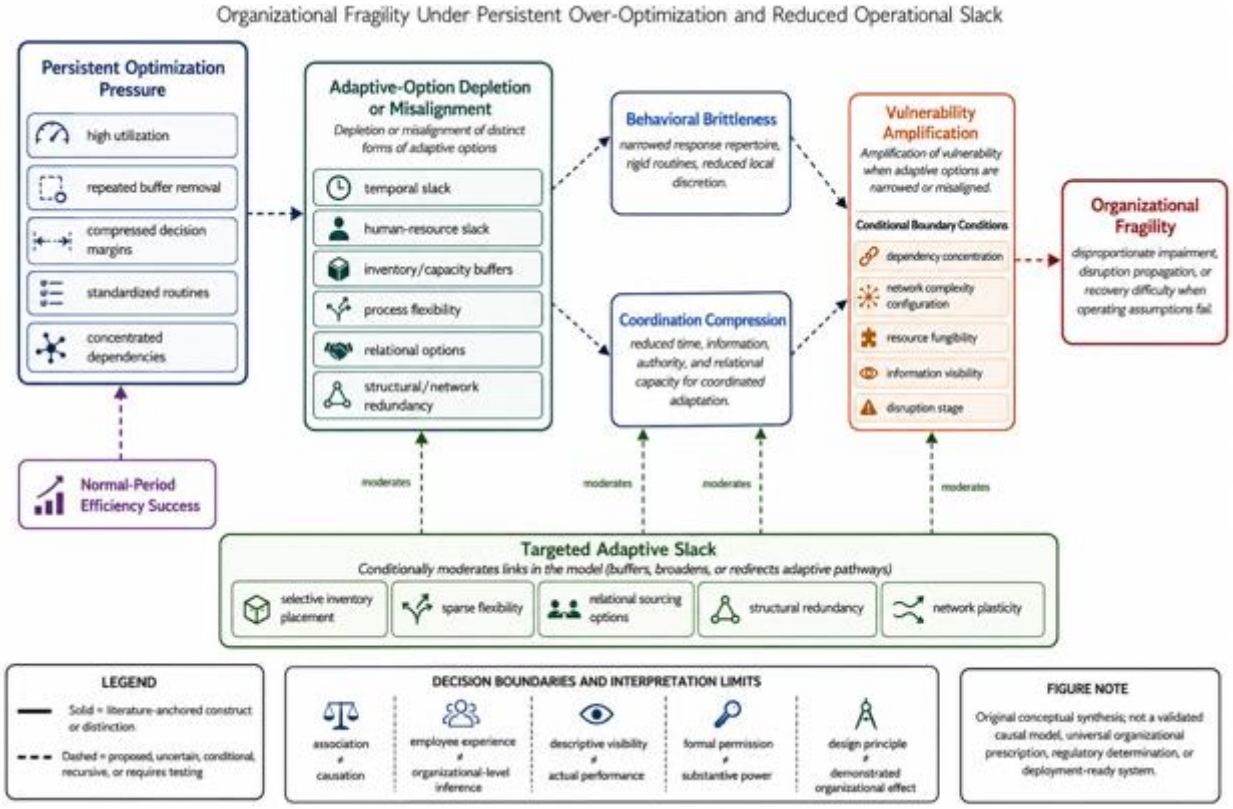

Figure 1. Theory of Over-Optimized Fragility

The figure is an original conceptual synthesis developed for "Organizational Fragility Under Persistent Over-Optimization and Reduced Operational Slack." Arrows and grouping indicate evidence-supported or proposed relationships rather than measured effect sizes. The figure does not represent a validated causal model, universal organizational prescription, regulatory determination, or deployment-ready system.

The theory distinguishes adaptive-option depletion from simple resource scarcity. Flexibility and redundancy can jointly affect modeled resilience, but their contributions depend on configuration rather than undifferentiated quantity [21]. Likewise, inventory located beyond the focal organization can influence disruption outcomes, demonstrating that relevant buffers may be distributed across network tiers rather than visible on one firm's balance sheet [22]. This distributed view makes the location and accessibility of slack theoretically as important as its aggregate amount.

TOF also allows adaptation to involve structural change. Evidence on supply-chain plasticity indicates that organizations may respond through network reconfiguration rather than merely restoring a previous configuration [23]. The proposed theory therefore treats recovery to the status quo as only one response pathway. Persistent optimization becomes fragile when it removes not only reserves but also feasible reconfiguration options. Adaptive capacity may therefore be distributed across

process flexibility, inventories located at different network tiers, and the capacity to reconfigure network structure rather than residing in a single undifferentiated stock of organizational slack [20, 22, 23].

Table 2 organizes the evidence, constructs, relationships, uncertainties, and boundary conditions required for proposed mechanisms, relationships, and organizational consequences in organizational fragility under persistent over-optimization and reduced operational slack.

Table 2. Proposed mechanisms, relationships, and organizational consequences in Organizational Fragility Under Persistent Over-Optimization and Reduced Operational Slack.

Mechanism or relationship	Antecedent	Mediator or process	Moderator	Expected consequence	Supporting evidence	Rival explanation	Validation requirement
Cross-domain option depletion — proposed	Persistent optimization	Removal or misalignment of deployable options	Resource fungibility; slack location	Greater sensitivity to assumption failure	Slack, inventory, flexibility, and distributed-buffer studies	General resource scarcity	Longitudinal pre-disruption measures across domains
Behavioral brittleness — proposed	Recurrent optimization around stable conditions	Narrowed routines and response repertoire	Learning; discretion; skills	Fewer feasible responses	Routine-rigidity and resilience-learning evidence	Culture or competence deficits	Direct behavioral-repertoire and temporal-process measures
Coordination compression — proposed	Tight time, authority, or information margins	Delayed diagnosis, escalation, and reallocation	Lead time; interdependence	Slower collective adaptation	Network-adaptation and responsiveness evidence	Poor leadership or information quality	Event-sequence and multilevel coordination studies
Dependency amplification — proposed	Concentrated or tightly coupled dependencies	Local disturbance propagates through constrained alternatives	Network configuration; disruption stage	Wider impairment or slower recovery	Complexity and concentration studies	Greater initial shock severity	Network designs separating common shocks from propagation
Adaptive-slack moderation — proposed	Retained deployable options	Buffering, substitution, or reconfiguration	Option type, timing, and location	Reduced mismatch between disruption demands and response capacity	Flexibility, inventory, and redundancy research	General managerial quality	Matched, longitudinal, or quasi-experimental tests
Reconfiguration pathway — proposed	Failure of prevailing configuration	Structural or relational redesign	Network plasticity; sourcing structure	Recovery through a changed configuration	Network-reconfiguration evidence	Selection into stronger networks	Longitudinal topology and relationship data

TOF does not claim that these mechanisms form a validated causal chain. Rather, it proposes that persistent over-optimization may increase fragility when the depletion of adaptive options precedes behavioral brittleness or coordination compression and when dependency structures amplify the resulting mismatch.

Theoretical propositions

The propositions translate TOF into relationships that can be challenged empirically. Their purpose is not to prescribe an optimum level of slack but to identify conditions under which the theory should or should not hold. Research on sparse flexibility shows that selectively configured response capacity can provide reliability without constructing complete redundancy [24]. This supports a configurational rather than maximalist view of adaptive slack.

Proposition 1 — Persistence. Persistent optimization that removes adaptive options across multiple domains is proposed to increase organizational fragility more strongly than isolated reduction of a single slack resource.

Proposition 2 — Behavioral brittleness. The proposed relationship between adaptive-option depletion and fragility is expected to be partly transmitted through narrowing of the enacted response repertoire.

Relational practices and network complexity can condition relationships between resilience capabilities and performance [25]. TOF therefore expects the organizational consequences of depleted slack to depend on the relational environment in which response occurs rather than on internal resources alone.

Proposition 3 — Coordination compression. Adaptive-option depletion is proposed to increase fragility when it reduces the time, information, authority, or relational capacity available for coordinated diagnosis and resource reallocation.

Proposition 4 — Vulnerability amplification. Dependency concentration and particular forms of network complexity are proposed to strengthen the relationship between adaptive-option depletion and disruption propagation, conditional on disruption stage and available alternatives.

Structural redundancy can also be defined as a network property rather than merely as excess inventory or spare capacity [26]. This distinction supports the expectation that slack portfolios can span levels of analysis.

Proposition 5 — Adaptive slack. Selectively positioned adaptive slack is proposed to weaken the relationship between disruption magnitude and organizational impairment more effectively than indiscriminate redundancy when the retained options match the demands of the disruption.

Proposition 6 — Configurational fit. The resilience value of slack is proposed to depend jointly on slack type, location, fungibility, network topology, disruption mode, and response phase.

These propositions remain theoretical predictions. None of the cited studies tests the full construct system, mediation architecture, temporal ordering, or cross-domain feedback structure proposed by TOF.

Designing for adaptive slack

Designing for adaptive slack should not be interpreted as restoring every resource previously removed in the pursuit of efficiency. Evidence on recovery from sourcing interruptions shows that sourcing strategies have differentiated consequences: diversification does not automatically accelerate recovery, whereas durable supplier relationships may support recovery under particular conditions [27]. Thus, the number of alternatives is an incomplete indicator of adaptability. Relational reliability, switching feasibility, and the location of disruption can matter as much as nominal redundancy.

A second principle concerns granularity. Research on "microdosing" flexibility demonstrates that small quantities of correctly positioned flexibility can improve responsiveness within an otherwise efficient supply-chain design [28]. TOF extends this logic conceptually by treating adaptive slack as an option portfolio rather than a stockpile. Temporal discretion, cross-training, spare capacity, alternative suppliers, decentralized authority, and structural reconfiguration capacity may each be valuable when positioned near the failure modes they are intended to absorb.

The broader evidence also cautions against collapsing resilience and efficiency into a single optimization objective. Recent synthesis emphasizes that recurrent operating risk and major disruption risk create different design problems and require deliberate balancing rather than a universal solution [29]. Designing for adaptive slack should therefore begin with plausible disruption modes, dependencies, response lead times, and substitution constraints rather than a generic target for "more slack." Design principles should remain conditional on context, risk structure, and organizational level.

Adaptive slack consequently represents a bounded design principle, not an implementation prescription. Designing for adaptive slack favors context-sensitive combinations of sourcing relationships, selectively positioned flexibility, and explicit resilience-efficiency balancing rather than indiscriminate redundancy [27-29]. Organizations may also possess formal options that are unusable because decision rights, information access, contractual conditions, or timing prevent deployment. Future testing must therefore distinguish nominal availability from substantive mobilizability and compare the cost of retained options with their contribution under both normal and disrupted operating conditions.

Conclusion

This article proposes the Theory of Over-Optimized Fragility to explain how sustained optimization may become organizationally hazardous when it progressively removes or misaligns the options needed to respond to deviations from prevailing operating assumptions. The theory distinguishes efficiency from over-optimization, operational slack from adaptive slack, and ordinary performance deterioration from the proposed condition of organizational fragility.

Its central contribution is a conditional process model in which adaptive-option depletion may generate behavioral brittleness and coordination compression, while dependency structures and disruption characteristics shape whether vulnerability is amplified. Adaptive slack is proposed as a selective and mobilizable portfolio of options rather than generalized redundancy.

The theory remains non-empirical. Its constructs, temporal ordering, mediating mechanisms, nonlinearities, and boundary conditions require direct measurement and comparative testing across organizational and network levels. Alternative explanations—including managerial quality, shock severity, industry structure, technological capability, resource scarcity, prior experience, and institutional context—must be examined rather than treated as residual noise. Accordingly, TOF should be understood as a falsifiable conceptual explanation and research agenda, not as a validated causal model, universal prescription, or deployment-ready organizational system.

Acknowledgments: None

Conflict of interest: None

Financial support: None

Ethics statement: None

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