



Managing Supply Chain Resilience under Recurrent Disruption: Capabilities, Digitalization, and Performance

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Abstract

Recurrent supply chain disruptions require coordinated managerial capabilities, but existing research often examines risk management, digital technologies, relationships, and performance separately. This structured integrative review synthesized 30 peer-reviewed journal studies published in 2020–2025, identified through iterative searches of publisher platforms, DOI-indexed scholarly records, and reference lists. Eligibility required an explicit supply chain resilience focus and a managerial, digital, governance, or performance relationship. Study designs, nine non-exclusive capability categories, digitalization, and performance links were mapped descriptively. Sixteen studies carried survey-based method labels. Flexibility (16 studies), collaboration (15), visibility and information (14), digitalization and analytics (13), risk management (12), and adaptability (12) were prominent; these frequencies indicate research attention, not comparative effectiveness. Across empirical and conceptual contributions, digitalization was associated with resilience chiefly through information quality, earlier detection, decision support, and interorganizational coordination, subject to governance and operational response capacity. Performance relationships concerned continuity, recovery, firm outcomes, and sustainability, with cost and dependency trade-offs. The resulting synthesis-derived architecture distinguishes managerial and governance foundations, information and relational enablers, executable operational options, and performance protection. Unlike a simple capability inventory, it specifies where complementarities and bottlenecks may arise without claiming a validated causal sequence. The bounded, heterogeneous corpus does not support pooled causal estimates or exhaustive coverage.

Keywords: digital transformation, managerial capabilities, risk management, supply chain management, supply chain resilience



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INTRODUCTION

Recurrent supply chain disruption has altered the managerial problem from restoring an isolated interruption to sustaining coordinated operations under successive and potentially correlated shocks. Pandemic restrictions, transport constraints, geopolitical conflict, climate-related events, cyber exposure, and demand volatility can affect different network nodes simultaneously, limiting the usefulness of contingency plans designed around a single failure. Earlier reviews mapped the expanding conceptual and relational scope of resilience without settling how its constituent capabilities should be organized for management decisions (Ali & Gölgeci, 2019). An adaptive-cycle account emphasizes adjustment as disturbances unfold (Adobor, 2020), whereas the viability perspective extends beyond short-term recovery to the structural survival of a supply network (Ivanov, 2020). Wieland and Durach (2021) likewise distinguish interpretations of resilience that imply different analytical boundaries. These perspectives converge on the importance of adjustment but differ in whether the principal object is the firm's capacity, network relationships, or a system's continued viability. Their coexistence makes the configuration and activation of capabilities, rather than a generic assertion of resilience, the central management question.

The resource-based perspective explains why visibility, connectivity, and available response resources can protect supply chains, but possession of resources does not establish their effective use. Foundational empirical research linked disruption orientation and resource reconfiguration to firm

resilience (Ambulkar et al., 2015), while contingent resource configurations associated visibility and connectivity with robustness and resilience (Brandon-Jones et al., 2014). These studies provide theoretical context rather than observations included in the 2020–2025 coding corpus. More recent evidence identifies managerial microfoundations: social capital, human capital, and cognition contribute to the development of visibility, responsiveness, and flexibility (Nikookar & Yanadori, 2022). The distinction matters because a supplier alternative, digital platform, or inventory buffer represents a potential option, whereas interpretation, decision authority, and cross-functional coordination determine whether that option can be activated. Dynamic capabilities consequently provide the principal organizing lens for the review; resource-based explanations clarify available assets, relational governance explains coordination across organizational boundaries, and viability identifies the longer-term outcome of reconfiguration.

Risk-management research supports preparedness, although it does not establish a uniform relationship between particular mitigation practices and resilience outcomes. El Baz and Ruel (2021) report mitigating associations between risk-management practices and disruption impacts, while Um and Han (2021) indicate that the contribution of resilience capabilities depends on the mitigation strategies used in different risk settings. Ozdemir et al. (2022) place risk management alongside supply chain velocity, and Dwaikat et al. (2022) distinguish robustness, redundancy, resourcefulness, and rapidity. These contributions agree that anticipation and response capacity should be connected, but they assign different analytical weight to protective buffers, rapid action, and the capacity to mobilize resources. Treating these dimensions as interchangeable obscures their costs and temporal roles. Risk identification without actionable alternatives may improve awareness without maintaining continuity; redundancy without exposure-specific prioritization may increase fixed costs without protecting critical flows. The unresolved issue is therefore the configuration of risk-related practices with information, governance, and operational options, not simply the presence of formal risk management.

Digitalization presents a parallel distinction between technological availability and organizational capability. Zouari et al. (2021) associate digital maturity and tool adoption with resilience, while Spieske and Birkel (2021) connect Industry 4.0 applications with anticipation, response, and recovery mechanisms. Evidence on analytics links data-processing capabilities with risk management, information quality, resilience, and firm performance (Bag et al., 2023; Bahrami & Shokouhyar, 2022). Artificial-intelligence-oriented contributions identify potential gains in innovation, decision support, and resilience under dynamic conditions (Belhadi, Mani, et al., 2021; Belhadi, Kamble, et al., 2022). The findings converge more clearly on sensing and coordination mechanisms than on an independent effect of technology ownership. Their designs also differ: cross-sectional associations, decision frameworks, and broader conceptual syntheses do not carry equivalent causal weight. The relevant theoretical question is when digital information becomes usable organizational action, particularly where data quality, decision rights, supplier participation, or physical capacity constrain the response.

Relational governance further limits technology-centered explanations because visibility across a supply network depends on information-sharing permissions, incentives, trust, and negotiated action. Paulraj and Irawan (2021) question whether digital transformation can compensate for weakened trust in strategic supplier relationships. Herold et al. (2021) document logistics responses combining digital tools with transport flexibility, infrastructure adjustment, and personnel capacity, while Gebhardt et al. (2022) identify collaboration and risk assessment among continuing post-disruption priorities. Lotfi (2022) differentiates the contributions and constraints of vertical and horizontal collaboration. These accounts broadly support joint problem solving but differ in the extent to which formal coordination or relational adjustment can be generalized across settings. Partner data may improve early warning while creating concerns about disclosure, dependence, and response authority. The distinction between information availability and coordinated execution is therefore necessary: digital connectivity can reduce information delay, but governance determines whether legally separate organizations can act on the resulting signal.

Operational responses also vary by context and duration. Manufacturing and service networks face different constraints when recovering from disruption (Belhadi, Kamble, et al., 2021), and blockchain-supported business model design has been linked to resilience and firm performance without replacing operational execution (Li et al., 2022). Digitalization and collaboration may operate jointly, while formal contracts modify their relationships with resilience and robustness (Li et al., 2023). Configurational evidence identifies multiple combinations of absorptive, reactive, and restorative

capacities associated with resilience (Gaudenzi et al., 2023), and a dynamic-capability and relational account links resilience antecedents to performance outcomes (Pu, 2023). These findings challenge additive capability inventories in which a larger number of practices necessarily implies greater resilience. Flexibility denotes switching within an existing operating arrangement, whereas adaptability denotes deeper changes in sourcing, processes, network structure, or governance. A configuration suited to a temporary transport closure may not sustain viability during a prolonged structural disruption.

Recent empirical studies extend these arguments to procurement, firm-level digital transformation, and strategic trade-offs. Harju et al. (2023) link procurement digitalization with resilience, while Qi et al. (2024) and Ge and Bao (2024) report positive relationships between digital transformation and resilience using listed-firm data. Such designs extend beyond self-reported managerial perceptions, but observational associations remain vulnerable to reverse causality, omitted managerial capabilities, and proxy-measurement limitations. Han and Um (2024) connect risk management with sustainability-related resilience capabilities, whereas Doetsch and Huchzermeier (2024) identify common implementation barriers, including budget and product complexity, across resilience and sustainability agendas. Scholten et al. (2025) emphasize the range of available response options, and Nikookar et al. (2025) distinguish necessary antecedents from capabilities that may be compensatory. Gomes and Miranda Silva (2025) examine digitalization in relation to Triple-A capabilities, linking agility, adaptability, and alignment to resilience. Together, these studies indicate that performance protection depends on compatible capabilities and contextual constraints, but they do not establish a common outcome metric or universal causal ordering.

Existing syntheses clarify important components of this problem without fully integrating their managerial relationships. The dynamic-capabilities meta-review of Stadtfeld and Gruchmann (2024) organizes resilience as capability development; Spieske and Birkel (2021) concentrate on Industry 4.0 contributions; and Hosseini Shekarabi et al. (2025) survey risk mitigation, robust optimization, and technological solutions. The broader mapping of Ali and Gölgeci (2019) demonstrates conceptual breadth, while the systematic-review logic outlined by Snyder (2019) supports synthesis across heterogeneous designs. The limitation for the present purpose is one of analytical emphasis rather than an absence of prior reviews: capability identification, technology applications, risk solutions, and resilience outcomes are not consistently traced through a shared management chain. In particular, it remains unclear which capabilities function as enabling conditions, how digital information and partner governance interact, which options can be executed under disruption, and how resulting outcomes are evaluated. A frequency map alone cannot settle these relationships because conceptual prominence is neither proof of necessity nor an estimate of effectiveness.

The review addresses this bounded integration problem through three linked research questions: RQ1, which managerial capabilities recur in the 2020–2025 literature, and how are their operational roles differentiated; RQ2, through which information-processing and coordination mechanisms is digitalization associated with those capabilities; and RQ3, how are capability configurations connected to continuity, recovery, firm performance, and sustainability outcomes? RQ1 is examined through nine non-exclusive capability codes and their descriptive recurrence; RQ2 through digitalization indicators and cross-study interpretation of enabling mechanisms; and RQ3 through reported performance linkages, implementation constraints, and differences in evidentiary status. Dynamic capabilities supply the organizing lens, with resource-based, relational-governance, Triple-A, and viability perspectives specifying complementary mechanisms and outcome boundaries. The contribution is a synthesis-derived, layered management architecture that distinguishes human and governance foundations, information and relational enablers, operational response options, and performance protection. It is proposed as an interpretive framework for diagnosing capability bottlenecks, not as an empirically validated hierarchy, a pooled effect estimate, or a universally optimal sequence of investments.

RESEARCH METHODS

The study used a structured integrative review and evidence-mapping design. The analytical corpus was deliberately bounded to 30 peer-reviewed journal studies published from 2020 through 2025 whose primary focus was supply chain resilience and whose abstract or full-text description contained an explicit managerial capability, practice, governance mechanism, digital enabler, or performance relationship. Searches were conducted iteratively across publisher platforms, DOI-indexed scholarly search results, and reference lists of high-relevance articles using combinations of the terms supply chain

resilience, management, capabilities, risk management, digitalization, collaboration, flexibility, visibility, performance, and disruption. The objective was analytic saturation across management themes rather than an exhaustive census of every resilience publication. This choice follows the integrative-review logic described by Snyder (2019), in which heterogeneous evidence is synthesized to develop a more coherent conceptual understanding. Older foundational studies were retained for theoretical framing but were not included in the 30-study coding corpus.

Each study was coded on publication year, broad research method, whether digitalization or analytics was a central explanatory element, whether the study explicitly linked resilience to an operational or firm-level performance outcome, and the managerial capabilities emphasized in its argument or findings. The capability dictionary was developed iteratively from the corpus and consolidated into nine categories: visibility and information, collaboration, flexibility, risk management, digitalization and analytics, adaptability and reconfiguration, redundancy, managerial human capital and leadership, and sustainability or viability. A study could receive more than one capability code because resilience research frequently treats capabilities as complementary bundles. Coding frequencies are descriptive evidence-map counts rather than effect sizes, and they do not imply that a frequently studied capability is more causally important than a less frequently studied one. Conceptual and review articles were retained because they contribute to the architecture used by empirical work, while survey, case, Delphi, configurational, panel, and analytics studies contribute different forms of empirical evidence.

Table 1. Structured Integrative Review Protocol

Element	Specification	Interpretive Role
Review purpose	Synthesize recent management evidence on supply chain resilience	Capability integration rather than effect-size pooling
Coded corpus	30 peer-reviewed journal studies, 2020-2025	Recent evidence base
Eligibility	Explicit resilience construct plus managerial capability, digital enabler, governance mechanism, or performance link	Keeps management relevance central
Coding units	Study-level year, method, capability tags, digitalization, performance linkage	Supports descriptive evidence mapping
Capability categories	9 non-exclusive categories	Allows capability bundles
Excluded from counts	Foundational pre-2020 studies and contextual references	Used for theory only
Inference boundary	No pooled causal effect; no ranking of firms or technologies	Respects heterogeneous study designs

Source: Authors' review protocol.

The synthesis proceeded in three stages. First, the corpus profile was summarized by year and method to identify the balance between quantitative, qualitative, conceptual, and review-based evidence. Second, capability codes were compared across studies to identify recurring management bundles and the role played by digitalization. Third, performance linkages and implementation tensions were synthesized, with particular attention to continuity, recovery, firm performance, sustainability, cost, governance, trust, and complexity. The interpretation used triangulation across methods rather than statistical pooling because the studies employ different constructs, scales, sectors, and model specifications. A positive association reported in a cross-sectional survey, for example, was not treated as equivalent to a causal effect, while conceptual frameworks were not counted as empirical confirmation. This separation preserves the evidentiary status of the original designs.

Table 1 records the review protocol and its interpretive boundaries. The evidence matrix was checked for duplicate studies, coding consistency, and the presence of a traceable DOI or publisher record for the journal literature used in the final synthesis. No participant-level data were collected, and no confidential corporate records were used. The review is reproducible at the level of the stated corpus and coding rules, but it is not a substitute for a database-complete systematic review because the search

was deliberately management-focused and bounded. That limitation is material: publication bias, language restrictions in scholarly search, uneven indexing, and the rapid appearance of new resilience research can alter the relative frequency of themes. The value of the design lies in transparent cross-study comparison rather than claims of exhaustive coverage.

RESULTS AND DISCUSSION

Managerial Capability Architecture for Resilience

The 30-study corpus shows that recent resilience research is empirically active but methodologically uneven. Quantitative designs account for most of the coded studies, especially surveys using structural equation modeling, regression, configurational analysis, and panel econometrics. Conceptual studies remain influential because they define the temporal and structural meaning of resilience, while reviews and meta-reviews consolidate rapidly expanding terminology. Figure 1 shows that the corpus becomes denser after the pandemic shock, with a visible concentration in 2021-2024. The pattern is consistent with the field's shift from early conceptualization toward capability testing and implementation questions. Adobor (2020) and Ivanov (2020) provide broad dynamic interpretations, whereas El Baz and Ruel (2021), Zouari et al. (2021), and Nikookar and Yanadori (2022) test specific capability relationships. Stadtfeld and Gruchmann (2024) then synthesize this accumulated literature through dynamic capabilities. The evidence base is consequently strong enough to identify recurring management mechanisms, but not homogeneous enough to support a single universal effect estimate.

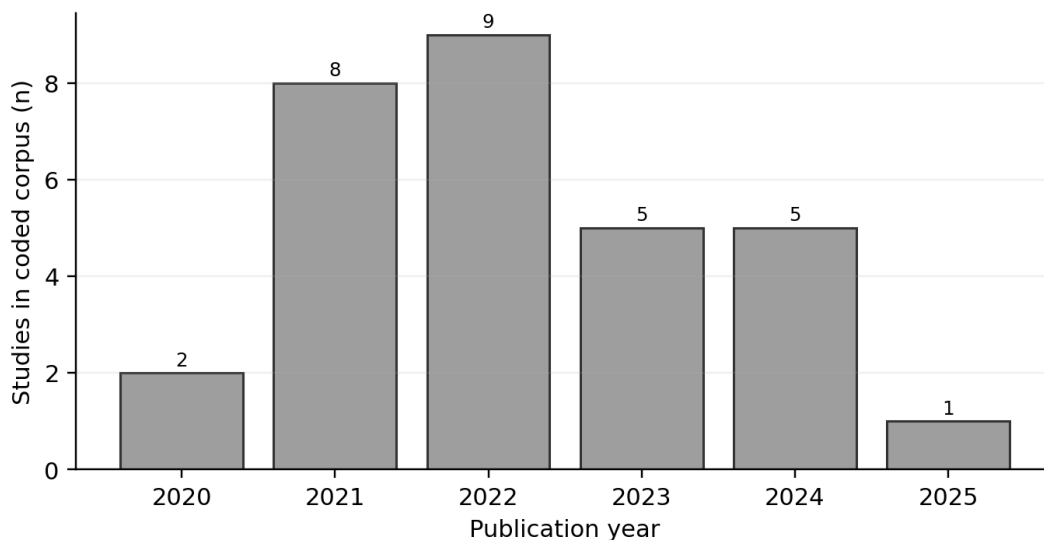


Figure 1. Publication-Year Distribution of the 30-Study Coded Corpus

Source: Authors' coding of the structured review corpus.

Visibility and information appear as the most recurrent capability family in the coding. The category covers supply chain visibility, information quality, timely risk detection, data integration, and the capacity to see dependencies beyond the focal firm. Brandon-Jones et al. (2014) established an early resource-based explanation of why visibility and connectivity matter for resilience, and recent studies repeatedly return to the same mechanism. Zouari et al. (2021) connect digital maturity with visibility-related resilience factors, Bahrami and Shokouhyar (2022) connect analytics with information quality, and Harju et al. (2023) show how procurement digitalization supports resilience. Visibility is not simply a dashboard property. Its management value depends on whether the information is decision-relevant, shared across organizational boundaries, and linked to authority for action. A network can possess extensive data yet remain slow if warnings are not interpreted, if suppliers conceal exposure, or if escalation routines are unclear. The synthesis therefore treats visibility as an information-processing capability rather than a technology category.

Table 2. Method Profile of the Coded Corpus

Research Method	Studies (n)	Share
Survey/SEM	10	33.3%
Conceptual/theoretical	3	10.0%
Panel econometric	2	6.7%
Survey/PLS-SEM	2	6.7%
Systematic review	2	6.7%
Case/comparative	1	3.3%
Decision/analytics	1	3.3%
Delphi study	1	3.3%
Meta-review	1	3.3%
NCA survey	1	3.3%
Qualitative interviews	1	3.3%
Survey	1	3.3%
Survey/mediation	1	3.3%
Survey/regression	1	3.3%
Thematic review	1	3.3%
fsQCA	1	3.3%

Source: Authors' coding. Categories summarize the principal design of each study.

Collaboration forms a second major cluster and functions as the bridge between information and coordinated response. Lotfi (2022) distinguishes vertical and horizontal collaboration, while Herold et al. (2021) show how logistics service providers relied on flexible operational coordination during the pandemic. Paulraj and Irawan (2021) demonstrate that joint problem solving and trust remain relevant even under digital transformation, and Li et al. (2023) identify collaboration as an important mechanism linking digitalization to resilience and robustness. The evidence indicates that collaboration contributes through faster problem recognition, access to partner resources, joint prioritization, and negotiated changes to delivery, capacity, or product plans. It also carries governance costs. Sharing sensitive data can increase dependence, contracts can constrain improvisation, and collaboration requires managerial attention before a crisis occurs. Resilience benefits are consequently more plausible where relational routines and information rights are established before disruption rather than improvised after material shortages appear.

Flexibility and adaptability are closely related but analytically distinct in the corpus. Flexibility refers to the ability to switch suppliers, production schedules, transport modes, product configurations, or capacity allocations within an existing architecture. Adaptability refers to deeper reconfiguration when the architecture itself must change. Ambulkar et al. (2015) emphasize resource reconfiguration at the firm level, while Belhadi, Kamble, et al. (2021) show that manufacturing and service networks require different response arrangements. Gaudenzi et al. (2023) further demonstrate that different configurations of capacities and strategies can achieve resilience, supporting an equifinality interpretation. Ivanov's (2020) viability model extends the logic to structural redesign over longer horizons. This distinction matters to managers because flexibility investments are often easier to price and test than adaptability. A second source, extra inventory, or alternative carrier can be evaluated before a shock; changing the network footprint, product architecture, or governance model requires broader strategic authority and may only become necessary when disruption persists.

Risk management is the capability cluster that most directly connects preparedness with response. El Baz and Ruel (2021) report that risk management practices mitigate disruption impacts, while Um and Han (2021) show that resilience capability mediates the relationship between global risk and outcomes under different mitigation strategies. Ozdemir et al. (2022) place risk management alongside velocity, and Dwaikat et al. (2022) integrate robustness, redundancy, resourcefulness, and rapidity in a capability framework. The common managerial lesson is that resilience requires both diagnostic and option-building activities. Risk identification without pre-authorized options can produce awareness without action, whereas redundant capacity without risk prioritization can create high fixed cost with little relevance to the dominant exposures. A resilient risk system links hazard recognition to trigger thresholds, response ownership, resource commitments, and post-event learning. This architecture also

explains why the same practice can appear effective in one setting and wasteful in another: the value depends on the disruption that the practice is designed to absorb.

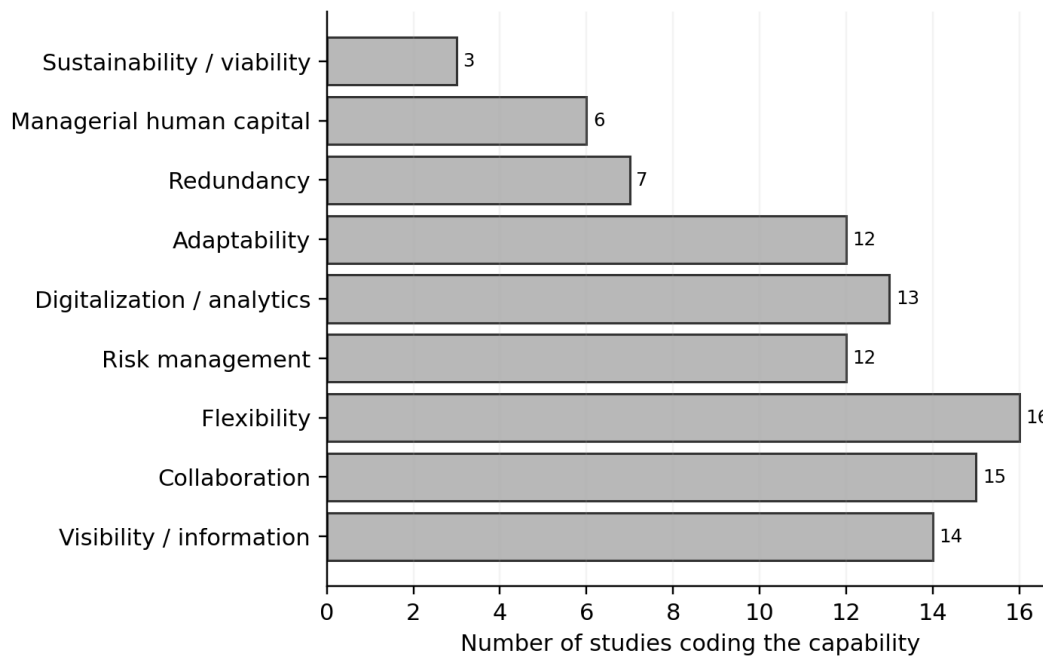


Figure 2. Frequency of Managerial Capability Codes

Source: Authors' coding. Studies can receive more than one capability code; counts are not effect sizes.

Redundancy receives less attention than visibility, collaboration, and flexibility, yet its role is conceptually important. Inventory buffers, alternate suppliers, spare capacity, and duplicated logistics routes increase the set of response options available when a primary resource fails. Suryawanshi and Dutta (2022) show that optimization research frequently treats resilience through risk, uncertainty, and resource-allocation trade-offs. Gebhardt et al. (2022) found that post-pandemic resilience thinking favors several bridging measures, including collaboration and risk assessment, rather than relying only on large safety stocks. Dwaikat et al. (2022) also position redundancy as one component in a broader resilience portfolio. This suggests a management shift from indiscriminate buffering toward selective redundancy. The economic problem is to identify which nodes warrant duplication, how much slack is justified, and which alternatives remain genuinely independent under correlated disruption. Diversification can fail if supposedly separate suppliers depend on the same upstream region, infrastructure, software provider, or regulatory regime.

Managerial human capital and leadership appear less frequently as explicit constructs than operational capabilities, but the studies that examine them assign a foundational role. Nikookar and Yanadori (2022) show that managers' social capital, human capital, and cognition help build organizational antecedents of resilience. Herold et al. (2021) highlight personnel capacity and managerial adaptation during the logistics shock, while Paulraj and Irawan (2021) show that relational quality remains relevant even when digital tools expand. Nikookar et al. (2025) sharpen the argument by identifying responsiveness and collaboration as necessary antecedents in their sample, implying that some capability levels cannot be compensated for by strength elsewhere. These findings make resilience partly a talent-management issue. Firms need managers who can interpret weak signals, coordinate across functions, negotiate with partners, and make decisions under incomplete information. Technology and redundancy can enlarge the option set, but leadership determines whether the option set is activated coherently.

The evidence also supports a layered rather than additive interpretation of capabilities. A simple scorecard that awards one point for each practice would imply that ten unrelated practices are necessarily superior to five integrated ones. The corpus provides little support for that assumption. Gaudenzi et al. (2023) find multiple effective configurations, Li et al. (2023) show interaction among digitalization,

collaboration, and contractual governance, and Nikookar et al. (2025) distinguish necessary from merely contributory conditions. The management architecture in Figure 3 therefore places human and governance foundations below information and relational enablers, which in turn expand operational response options. The layers are not strictly sequential, but the arrangement reflects a recurring logic: managers build sensing and coordination capacity before they can exploit flexibility, redundancy, and reconfiguration at speed. This interpretation also aligns with the dynamic-capabilities synthesis of Stadtfeld and Gruchmann (2024), which treats resilience practices as evolving bundles rather than isolated routines.

Table 3. Recurrence of Managerial Capability Categories

Capability Category	Studies Coding the Capability	Share of Corpus
Visibility / information	14	46.7%
Collaboration	15	50.0%
Flexibility	16	53.3%
Risk management	12	40.0%
Digitalization / analytics	13	43.3%
Adaptability	12	40.0%
Redundancy	7	23.3%
Managerial human capital	6	20.0%
Sustainability / viability	3	10.0%

Source: Authors' evidence map; non-exclusive coding.

The first managerial implication is prioritization. Firms with limited resilience budgets should not begin by copying a long catalog of practices; they should diagnose where the capability chain currently breaks. If disruption is detected late, visibility and information quality require attention. If information is available but partners respond slowly, collaboration, governance, and decision rights are more likely constraints. If coordinated decisions are made but the network has no alternative capacity or sourcing routes, flexibility and targeted redundancy become central. If the shock changes the market or network for an extended period, adaptability and structural reconfiguration move to the foreground. Scholten et al. (2025) describe resilience as a funnel of response options, and Hosseini Shekarabi et al. (2025) similarly emphasize the variety of risk-mitigation, optimization, and technological solutions. A capability diagnosis offers a management logic for choosing among those options without treating every resilience investment as equally urgent.

Digitalization as an Information and Coordination Enabler

Digitalization appears in nearly half of the coded studies, but the evidence consistently treats technology as an enabler of management rather than a self-executing resilience mechanism. Zouari et al. (2021) found that digital maturity and digital-tool adoption contribute to resilience, while Spieske and Birkel (2021) show how Industry 4.0 technologies can support anticipation, response, and recovery. The distinction between maturity and tool ownership is important. A firm can install sensors, cloud platforms, supplier portals, or analytics software without changing the routines through which disruptions are detected and decisions are made. Digital resilience emerges when data from those tools become timely operational signals, when managers know how to interpret them, and when suppliers and internal functions can act on the same information. The coded literature consequently links digitalization most frequently with visibility, collaboration, and adaptability rather than with a direct technological path to performance.

Analytics strengthens resilience through a similar information-processing mechanism. Bag et al. (2023) show that big-data analytics can strengthen internal and external risk-management capabilities, and Bahrami and Shokouhyar (2022) connect analytics capability with information quality, innovation, resilience, and firm performance. Belhadi, Mani, et al. (2021) find that artificial-intelligence-driven innovation supports resilience and performance under supply chain dynamism. These studies converge on a practical management point: the value of analytics lies in reducing decision latency and improving the quality of alternatives. Forecast accuracy, anomaly detection, supplier-risk signals, and scenario

simulation can reduce uncertainty, but the organizational benefit depends on whether analytics is embedded in planning, sourcing, production, and logistics processes. Analytics teams separated from operating decisions may produce technically sophisticated outputs that arrive too late or lack the authority to change resource allocation.

The AI-oriented studies also introduce a model-governance problem. Belhadi, Kamble, et al. (2022) use interpretable artificial-intelligence techniques to support resilient decision making, illustrating the value of transparency where managers must justify supplier classifications or intervention choices. A resilience system that depends on opaque model outputs can create a new operational vulnerability if managers cannot understand why a warning was triggered or how stable it is under data drift. This issue becomes more important when disruption itself changes the data-generating process. Historical correlations learned during stable conditions may fail during a pandemic, war, or regulatory shock. The appropriate management response is not to reject AI, but to combine model output with scenario reasoning, human review, and explicit escalation rules. Digital tools should enlarge managerial sensing and analytical capacity without eliminating responsibility for judgment.

Table 4. Digitalization Evidence Patterns in the Review

Digital Mechanism	Representative Evidence	Primary Management Contribution	Principal Boundary
Digital maturity and tools	Zouari et al. (2021)	Visibility, anticipation, coordination	Tool ownership does not ensure use
Big-data analytics	Bag et al. (2023); Bahrami & Shokouhyar (2022)	Information quality and risk sensing	Data quality and decision integration
Artificial intelligence	Belhadi, Mani, et al. (2021); Belhadi, Kamble, et al. (2022)	Prediction, classification, decision support	Interpretability and model drift
Blockchain-enabled design	Li et al. (2022)	Traceability and interorganizational coordination	Governance, cost, adoption incentives
Procurement digitalization	Harju et al. (2023)	Supplier visibility and sourcing response	Standardization versus exception flexibility
Enterprise digital transformation	Qi et al. (2024); Ge & Bao (2024)	Alignment, productivity, supplier innovation	Context and proxy measurement

Source: Authors' synthesis of coded studies.

Blockchain research illustrates a different digital mechanism: coordination and traceability across organizational boundaries. Li et al. (2022) connect blockchain-supported business model design with resilience and firm performance, emphasizing how digital infrastructure can support both efficiency-oriented and novelty-oriented designs. The managerial value is strongest where multiple firms need a shared record of transactions, provenance, or commitments, but adoption costs and governance complexity remain material. A distributed ledger cannot resolve a capacity shortage by itself, and it cannot create supplier trust when commercial incentives encourage withholding information. Its resilience contribution comes from reducing information asymmetry, improving traceability, or accelerating verification inside a wider network arrangement. The same logic applies to digital twins, control towers, and collaborative planning platforms: technology can improve the quality and speed of coordination, yet the operational response still depends on contracts, authority, resources, and partner incentives.

Digital transformation also has firm-level evidence beyond surveys. Qi et al. (2024) use Chinese listed companies and find that enterprise digitalization is positively associated with supply chain resilience, with stronger effects in some ownership and marketization contexts. Ge and Bao (2024) similarly report that digital transformation strengthens supply chain resilience through improved supply-demand alignment, more stable relationships, supplier innovation, higher productivity, and lower resource misallocation. These panel studies broaden the literature because they move beyond manager perceptions and show that digitalization-resilience relationships can be detected in archival firm data. Their interpretation still requires caution. Text-based or financial proxies for digital transformation and

resilience may not capture the full operational mechanism, and listed-company results cannot be transferred automatically to small firms or informal supplier networks. The studies nevertheless reinforce the proposition that digitalization changes organizational coordination capacity, not only IT intensity.

Procurement provides a concrete management setting for these digital effects. Harju et al. (2023) show that procurement digitalization can improve resilience, which is plausible because procurement is the interface where supplier information, contracting, category strategy, and continuity planning meet. Digitized procurement systems can expose supplier concentration, track delivery reliability, speed alternative-source qualification, and support coordinated demand signals. They can also standardize processes so tightly that improvisation becomes difficult if exception handling is weak. Paulraj and Irawan (2021) caution that digital transformation does not remove the need for trust and joint problem solving. Li et al. (2023) likewise show that formal contracts can alter the relationship between digitalization, collaboration, and resilience. The managerial challenge is to design digital procurement so that standardized data and controls improve transparency while preserving relational capacity for exceptions and rapid renegotiation.

The corpus also reveals an important distinction between digital visibility and digital dependency. More integrated networks can detect upstream problems earlier, yet integration can increase reliance on common software, cloud infrastructure, communication standards, and cyber controls. This creates a resilience paradox: the technology that improves visibility can also become a shared point of failure. The reviewed studies rarely model this cyber-organizational trade-off directly, which represents an important research gap. The managerial response is to treat digital infrastructure itself as part of the supply chain risk map. Business continuity plans should identify critical data services, fallback communication channels, manual overrides, identity and access dependencies, and the supplier ecosystem supporting core platforms. Resilience management should ask not only whether digitalization improves supply chain visibility, but whether the visibility architecture remains available during the disruptions for which it was designed.

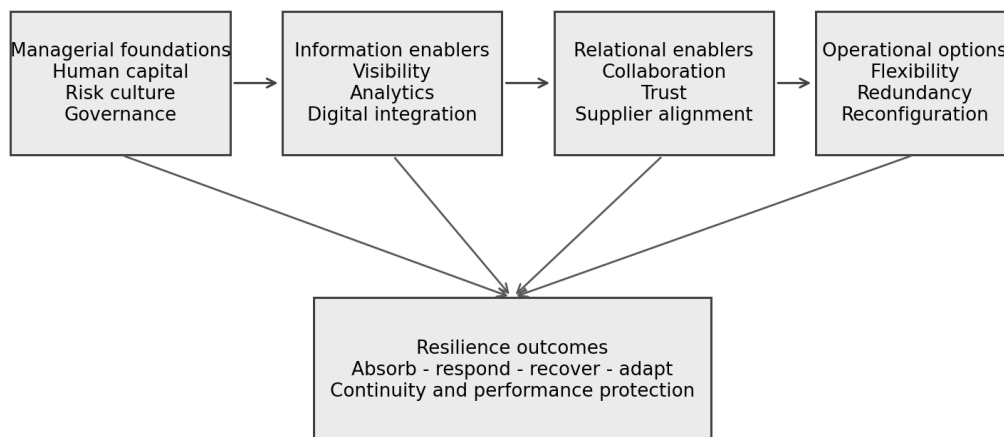


Figure 3. Layered Management Architecture for Supply Chain Resilience

Source: Authors' synthesis based on the coded capability relationships.

Performance measurement must reflect this enabling logic. A digital investment should not be judged only by system adoption, number of connected suppliers, or data volume. Measures closer to resilience include time to detect an interruption, time to validate its network exposure, time to approve an alternative action, the proportion of critical suppliers with usable tier-two information, recovery time, and the share of decisions executed before service levels breach a threshold. Bahrami and Shokouhyar (2022) connect information quality to performance through resilience, while Bag et al. (2023) emphasize the risk-management capabilities developed around analytics. These relationships suggest a measurement chain from technology to information quality, from information quality to coordinated

action, and from action to continuity or recovery. Managers can use that chain to separate digital spending that enlarges resilience capacity from spending that merely automates routine transactions.

The digital evidence supports a capability-complementarity conclusion rather than a technology-first conclusion. Digitalization is most valuable when it increases visibility, strengthens collaboration, reduces coordination delay, or improves the speed and quality of reconfiguration. Gomes and Miranda Silva (2025) explicitly analyze the interplay between digitalization and Triple-A capabilities, reinforcing the view that digital technology interacts with agility, adaptability, and alignment. Spieske and Birkel (2021) reach a similar conclusion from Industry 4.0 literature, while Li et al. (2023) demonstrate that collaboration mediates part of the digitalization-resilience relationship. Managers should consequently evaluate digital projects against the capability gap they are intended to close. A control tower may be valuable where visibility is poor, predictive analytics where detection is slow, and collaborative platforms where coordination is fragmented. Technology selection becomes a resilience-management decision only when it is tied to a specific managerial mechanism.

Performance Protection, Governance, and Managerial Trade-offs

Resilience research increasingly links capability investment to performance, although the outcome measures differ substantially. In the coded corpus, most empirical studies connect resilience to at least one operational, firm, or sustainability outcome. Belhadi, Mani, et al. (2021) report performance benefits associated with AI-driven resilience, Bahrami and Shokouhyar (2022) connect big-data capability and resilience to firm performance, and Li et al. (2022) position resilience as a mechanism within blockchain-supported business model design and firm performance. These findings support the economic relevance of resilience, but they should not be read as a uniform financial return. Some studies measure continuity, others use perceptual firm performance, and others focus on robustness, recovery, or sustainability. A manager cannot translate all positive coefficients into the same budgetary metric. The more defensible approach is to connect a resilience practice to the specific loss channel it is expected to reduce, such as downtime, lost sales, expedited freight, supplier failure, working-capital pressure, or customer-service deterioration.

Table 5. Outcome Linkages in the Coded Corpus

Outcome Dimension	Management Question	Representative Evidence
Continuity	Can critical flow be maintained during the shock?	Herold et al. (2021); Ozdemir et al. (2022)
Recovery	How quickly and how fully can performance be restored?	Adobor (2020); Gaudenzi et al. (2023)
Firm performance	Does resilience protect value, sales, or broader performance?	Bahrami & Shokouhyar (2022); Li et al. (2022); Pu (2023)
Sustainability	Do resilience choices preserve environmental and social objectives?	Han & Um (2024); Doetsch & Huchzermeier (2024)
Strategic adaptability	Can the network reconfigure when the disturbance persists?	Ivanov (2020); Stadtfeld & Gruchmann (2024)

Source: Authors' synthesis of performance and outcome linkages.

Continuity is the most immediate performance logic because disruption first appears as an inability to execute planned operations. Herold et al. (2021) show how logistics service providers adjusted transport, infrastructure, personnel, and revenue activities to maintain operations. Ozdemir et al. (2022) emphasize supply chain velocity, which captures the speed with which the network can continue or restore flow. The management implication is that resilience metrics should include both depth and duration of performance loss. Two firms may experience the same service decline but differ materially if one recovers in days and the other in months. Recovery time, backlog clearance, customer fill rate, production restart, and cash conversion can provide a more operational view than a single subjective resilience score. Such metrics also allow managers to test whether a particular capability reduces loss severity, accelerates recovery, or both.

Firm performance enters the literature through both direct and mediated relationships. Bahrami and Shokouhyar (2022) treat resilience as a mechanism through which analytics capabilities affect

performance, while Li et al. (2022) show that resilience mediates parts of the business-model-performance relationship. Pu (2023) likewise examines antecedents and outcomes using dynamic-capabilities and relational perspectives. The consistent theme is that resilience is valuable because it protects or restores the organization's ability to create value, not because resilience is an end in itself. This distinction is essential when management compares resilience investments with efficiency projects. Redundant capacity can lower utilization during normal periods, alternative suppliers can reduce volume discounts, and broader inventories can increase working capital. Their return appears when disruption losses that would otherwise occur are avoided or shortened. Economic evaluation should therefore consider expected loss, recovery value, option value, and strategic continuity, not only steady-state unit cost.

The efficiency-resilience tension is real but often overstated. Ivanov (2020) argues for viable supply chains that combine agility, resilience, sustainability, and survivability rather than treating them as mutually exclusive goals. Gebhardt et al. (2022) found that future resilience strategies may rely more on bridging mechanisms such as collaboration and risk assessment than on indiscriminate buffering. Gaudenzi et al. (2023) show that multiple configurations can achieve resilience, which means firms do not need the same portfolio of expensive safeguards. Selective redundancy, flexible contracts, shared data, modular designs, and prequalified suppliers can create response options without replicating the entire network. The management task is to identify where additional slack has the highest marginal value. A low-cost component with many qualified alternatives may need little buffer, while a high-criticality single-source input with long qualification lead times may justify substantial inventory or dual sourcing.

Governance determines whether resilience options can be activated across firm boundaries. Paulraj and Irawan (2021) show that trust and communication remain important in strategic supplier relationships, while Li et al. (2023) demonstrate that formal contracts can strengthen some digitalization effects but weaken other collaboration relationships. Lotfi (2022) similarly notes that collaboration benefits depend on governance and competition. These findings argue against a simplistic choice between relational and contractual governance. Resilient networks need clear obligations for information sharing, continuity, and emergency decision rights, yet they also need enough relational flexibility to manage conditions not anticipated in the contract. A governance system designed only for price and quality compliance may be too rigid for rapid disruption response. Managers should define escalation paths, temporary allocation rules, data-sharing expectations, and decision authority before crisis conditions compress negotiation time.

Sustainability adds another performance dimension. Han and Um (2024) show that risk management can contribute to sustainability and resilience capability, while Doetsch and Huchzermeier (2024) report substantial overlap between the implementation barriers facing resilience and sustainability. The two objectives can reinforce each other when supplier development, traceability, resource efficiency, and long-term collaboration improve both continuity and environmental or social outcomes. They can also conflict. Extra inventory increases storage and obsolescence, duplicated capacity can raise resource use, and emergency sourcing may reduce the ability to enforce environmental or labor standards. The managerial implication is not that one objective should dominate, but that resilience options should be evaluated across operational, financial, and sustainability criteria. A capability portfolio that protects service at unacceptable environmental or social cost can create a different class of strategic risk.

Recent theory also changes how management should interpret resilience maturity. Scholten et al. (2025) frame resilience around available response options, and Nikookar et al. (2025) distinguish necessary from contributory antecedents. This means maturity cannot be represented convincingly by a simple count of practices. A firm with sophisticated analytics but weak collaboration may still be unable to respond if partner action is required; a firm with broad supplier relationships but no timely visibility may detect the problem too late. The layered model in Figure 3 captures this asymmetry by showing that capability interactions matter. Managers can use maturity assessment to identify bottlenecks rather than to maximize the number of resilience practices. The objective is to create a coherent chain from sensing to coordination, response, recovery, and adaptation. Investments should target the bottleneck that prevents the next stage from functioning.

Table 5 translates the literature into outcome-oriented management questions. The table separates continuity, recovery, firm performance, sustainability, and strategic adaptability because the same

practice may affect these dimensions differently. A visibility investment may improve detection without changing physical recovery capacity; a redundant supplier may protect continuity but reduce purchasing leverage; a digital twin may support scenario planning yet require high-quality master data; a long-term collaboration agreement may improve coordination while increasing dependence on a small partner set. The evidence synthesis supports portfolio governance in which each resilience investment has an explicit target outcome, owner, trigger, cost logic, and review cycle. Such governance also makes post-disruption learning more useful because managers can compare expected and realized capability performance rather than merely documenting the event.

Table 6. Managerial Prioritization Matrix for Resilience Investment

Observed Bottleneck		Priority Capability	Indicative Management Action	Performance Check
Late detection	disruption	Visibility / analytics	Map tiered dependencies; automate exception alerts; define escalation thresholds	Detection lead time
Slow response	partner	Collaboration / governance	Pre-negotiate allocation, data-sharing, and emergency decision protocols	Decision-to-action time
No operating alternative	feasible	Flexibility / redundancy	Qualify alternate suppliers, routes, capacity, or product configurations	Service loss and recovery time
Repeated failure across scenarios		Risk management	Link scenario analysis to funded options and trigger rules	Expected loss reduction
Persistent structural change		Adaptability / reconfiguration	Redesign network footprint, contracts, and capacity allocation	Post-change continuity and margin
Resilience creates sustainability cost		Integrated governance	Evaluate options across cost, service, emissions, and social criteria	Multi-criteria performance balance

Source: Authors' synthesis; actions are diagnostic examples rather than universal prescriptions.

The combined evidence produces a management agenda centered on capability coherence. Firms should map critical flows and dependencies, identify where sensing or response fails, assign decision rights, and build a limited set of complementary options around the highest-consequence exposures. Digitalization should be tied to visibility or coordination gaps, collaboration should be supported by explicit governance, and redundancy should be selective rather than indiscriminate. Performance evaluation should measure avoided loss and recovery quality as well as normal-period efficiency. Sustainability criteria should be embedded where resilience choices alter sourcing, capacity, or inventory structures. The evidence remains heterogeneous, and the review cannot establish a universal causal ordering among capabilities. It does show, however, that recent research has moved decisively away from the idea that one technology, one buffer, or one best practice can deliver resilience. Management quality lies in configuring and renewing a portfolio that fits the network's disruption exposure, operating model, and strategic objectives.

CONCLUSION

The synthesis provides three distinct answers to the research questions. For RQ1, flexibility (16 studies), collaboration (15), visibility and information (14), digitalization and analytics (13), risk management (12), and adaptability (12) were the most frequently coded capabilities in the bounded 30-study corpus; redundancy (7), managerial human capital (6), and sustainability or viability (3) appeared less often as explicit codes. These values describe attention within the selected literature, not relative causal importance. For RQ2, digitalization was linked to resilience principally through earlier sensing, more usable information, decision support, and partner coordination; the evidence does not establish that technology adoption produces resilience independently of governance, managerial judgment, or

operational alternatives. For RQ3, reported outcomes included continuity, recovery, firm performance, and sustainability, subject to costs, complexity, interdependence, and differing measurement designs. Associations in the reviewed studies should not be interpreted as a common causal effect.

The principal theoretical contribution is a synthesis-derived management architecture that distinguishes four analytically related elements: human and governance foundations; information and relational enablers; operational flexibility, redundancy, and reconfiguration options; and performance protection. Dynamic-capabilities research explains how resources are renewed, relational governance addresses their coordinated activation, the Triple-A perspective differentiates responsive and adaptive arrangements, and viability extends the outcome horizon. The proposed architecture adds a diagnostic account of where the management chain can fail rather than simply adding more capabilities to an inventory. Its layering represents an interpretive proposition, not an empirically verified causal sequence or universal maturity scale. For managers, the implications are correspondingly conditional: late warnings point to information bottlenecks, delayed partner action to governance limitations, insufficient alternatives to targeted flexibility or redundancy, and persistent structural change to adaptation. Investments should be evaluated against specified continuity, recovery, financial, and sustainability measures, including their operating costs and dependencies.

These interpretations remain constrained by purposive selection of 30 studies, incomplete database and screening histories, uncertain coverage across contexts, heterogeneous primary and secondary evidence, possible overlap between review articles and empirical studies, and the absence of formal quality-weighted synthesis or pooled causal estimation. Non-exclusive code frequencies cannot establish capability sufficiency or substitute for direct performance comparisons. Subsequent research should publish auditable search and coding matrices, compare common outcome measures across sectors and firm sizes, and test whether visibility and collaboration function as necessary conditions or whether other capabilities compensate under particular disruptions. Longitudinal network and event-level studies could examine whether digital information improves recovery only when decision rights and physical options are available. Further comparative work should measure the cost of redundancy and the vulnerability introduced by shared platforms or concentrated digital infrastructure. Such tests would determine the validity and boundary conditions of the proposed conceptual relationships.

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