

Construction Organization Resilience: An Integrative Framework of Capabilities, Practices, and Measurement

Zulkfli Sapeciay, Mohd Zulakhmar Zakiyudin

Centre of Studies for Building Surveying, Faculty of Built Environment, Universiti Teknologi MARA,
Shah Alam, Malaysia

DOI: <https://doi.org/10.47772/IJRISS.2026.100800613>

Received: 25 August 2026; Accepted: 30 August 2026; Published: 14 September 2026

ABSTRACT

This review paper synthesizes empirical and theoretical research on organizational resilience in the construction sector across individual, team, project, firm, supply chain, and institutional levels, focusing on the historical and contemporary literature published between 2012 and 2026. Systematic shocks such as economic recessions, supply network disruptions, safety vulnerabilities, and the global COVID-19 pandemic have motivated a massive expansion of resilience-oriented research in construction. Through a rigorous systematic analysis, this paper organizes the fragmented literature into four integrated domains: (1) capability domains (including organizational learning, unlearning, data governance, and human resources), (2) structural and institutional elements, (3) operational mechanisms (procurement, backup sourcing, and digitalization), and (4) measurement and indices (validated psychometric scales, RAG-based systems, and computational models). Using a dynamic capability framing of sensing, seizing, and reconfiguring, this study traces how micro-level individual cognitive and psychological resources and team climates aggregate to shape meso-level project outcomes and macro-level institutional arrangements. The review demonstrates that while institutional factors and formal governance design anchor proactive preparedness (pre-crisis), resource endowments, material/financial buffers, and operational redundancy are decisive for reactive recovery (post-crisis). Furthermore, data governance and supply chain digitalization emerge as crucial cross-cutting enablers that accelerate information velocity and partially mediate performance gains under shock. Mechanistically and methodologically, the field is pluralistic, spanning qualitative case studies, psychometric scale validation, social network analysis (SNA), fuzzy cognitive mapping (FCM), and robust optimization, yet it suffers from heterogeneous measures and a lack of cross-context replication. This paper further presents a layered, multi-level integrative framework and establishes a prioritized research agenda focused on measurement harmonization, longitudinal multi-phase mixed methods, the integration of qualitative institutional analyses with quantitative models, and open tool development to transition construction practice toward a robust, adaptive, and resilient future.

Keywords: organisational resilience, organisational learning, data governance, supply-chain resilience, measurement scales

INTRODUCTION

The construction sector is inherently characterized by complexity, fragmentation, long project lifecycles, and a high sensitivity to macroeconomic and environmental disruptions. In recent years, a series of extreme, systemic shocks including the global COVID-19 pandemic, geopolitical tensions, severe material shortages, cost inflation, and regulatory changes has exposed deep vulnerabilities in construction organizations worldwide (Chih et al., 2022; Gupta et al., 2026). These disruptions have accelerated a paradigm shift in both academic research and industrial practice, moving from traditional risk-management frameworks oriented around predictability and static compliance toward the dynamic and systemic concept of organizational resilience. Broadly defined, resilience refers to an organization's capacity to proactively prepare for, absorb, rapidly recover from, and adaptively learn from disruptive events (Hilu & Hiyassat, 2024; Sapeciay et al., 2017).

Despite a growing volume of literature, research on construction organization resilience has developed in a fragmented manner, isolated across distinct levels of analysis and divergent theoretical traditions. On one hand, micro-level studies examine employee psychological resources, safety-related behaviors, and team climates (Gao et al., 2025; Wang & Peng, 2024). On the other hand, middle and macro-level studies investigate organization-level dynamic capabilities, supply chain logistics, and institutional rules governing mega infrastructure projects (Zhao et al., 2023; Chen et al., 2024). This structural division has hindered the formation of a cohesive, cross-level perspective that links micro-level cognition and behaviors to aggregate project performance and macro-level system survival. To address this gap, this review paper synthesizes empirical and theoretical contributions on construction resilience across multiple nested levels — individual, team, project, firm, supply chain, and institutional — aiming to produce a layered, integrative framework that connects capabilities, practices, and measurement approaches.

To ground the synthesis in contemporary methods and high-quality empirical evidence, the scope of this review emphasizes studies published between 2012 and 2026. This timeframe captures early seminal work on turbulence-triggered unlearning (Wong & Lam, 2012) and spans the rapid expansion of quantitative, digital, and computational methodologies developed during and after the pandemic (Hua et al., 2025; Saddique et al., 2023). Crucially, the review establishes clear boundaries by focusing strictly on organizational, socio-technical, and managerial processes. It excludes purely material, physical, or structural engineering resilience of physical construction components, ensuring that attention remains on the human, data, operational, and institutional networks that determine survival and adaptive growth in a volatile landscape (Jiao & Bu, 2024; Wang, Wu, & Zhang, 2022).

This review intends to make three interrelated contributions to the construction management literature. First, it synthesizes recurring capability domains such as organizational learning and unlearning, data governance and analytics, and human psychological resources and maps them to operational mechanisms, including supply chain continuity and ICT-enabled sensing (AlMaian & Bu Qammaz, 2023; Hua et al., 2025). Second, it catalogues and comparatively evaluates existing measurement instruments and scales, identifying key methodological differences between subjective survey scales and formal mathematical models (Rahi et al., 2025; Jiang et al., 2024). Third, it develops a layered integrative framework that maps directional linkages and feedback loops across scales, providing practical guidance for researchers and managers. By clarifying the conditional configurations of proactive preparedness versus reactive recovery, this paper establishes a coordinated, evidence-based research agenda to guide future inquiry (Wang, Wu, & Zhang, 2022; Zhao et al., 2023).

SYSTEMATIC REVIEW METHODOLOGY

To synthesize empirical and theoretical research on organizational resilience in the construction sector across nested levels (individual, team, project, firm, supply chain, and institutional), this study adopts a rigorous, transparent, and reproducible systematic literature review methodology. To ensure comprehensive coverage of the literature published between 2012 and 2026, three primary electronic databases were systematically searched: Scopus, Web of Science (WoS), and Google Scholar. Google Scholar was utilized specifically to capture highly relevant conference proceedings and emerging doctoral research that may not yet be fully indexed in Scopus or Web of Science. The search string was carefully designed using Boolean operators to target three intersecting domains: (1) the construction industry context, (2) the core concept of resilience, and (3) operational, managerial, or measurement elements. The exact search string applied was: ("construction" OR "built environment" OR "project") AND ("organizational resilience" OR "organisational resilience" OR "firm resilience" OR "supply chain resilience") AND ("capability" OR "measurement" OR "practice" OR "scale" OR "framework"). This initial database search yielded a total of 154 unique records.

To refine this initial pool, strict eligibility criteria were established. To be included in the review, studies had to meet the following inclusion criteria: (a) published in English in peer-reviewed journals or reputable conference proceedings between January 2012 and January 2026; (b) focus explicitly on the organizational, socio-technical, or managerial aspects of resilience within construction firms, project teams, or supply chains; and (c) present an empirical research design, a validated measurement scale, or an explicit theoretical/conceptual framework. Studies were excluded if they: (a) focused purely on the material, physical,

or structural engineering resilience of physical infrastructure assets (e.g., concrete durability, seismic resistance of buildings); (b) consisted solely of opinion pieces, book reviews, or non-peer-reviewed white papers; or (c) addressed resilience in non-construction sectors without a clear translation or application to construction management.

The screening procedures followed a multi-stage PRISMA flow model. First, duplicates were removed, and two researchers independently screened the titles and abstracts of the 154 identified records against the eligibility criteria, excluding 89 records. Second, the remaining 65 full-text articles were retrieved and evaluated in detail. To ensure scientific rigor, a quality assessment protocol was applied during the full-text review. Each article was critically appraised using a three-point quality check: (1) Theoretical Grounding: the study explicitly defines its resilience constructs and theoretical positioning; (2) Methodological Rigor: the research design, data collection, and analytical methods (such as PLS-SEM, SNA, or FCM) are transparently reported and validated; and (3) Sectoral Relevance: the findings provide direct, actionable insights for construction management. Articles failing to satisfy at least two of these criteria were excluded. After full-text screening and quality assessment, 38 papers were excluded due to lack of organizational focus or insufficient methodological detail, resulting in a final sample of 27 high-quality, peer-reviewed key studies that form the core empirical and theoretical baseline of this synthesis (as cataloged in Table 1).

Theoretical Foundations And Conceptual Evolution

The conceptualization of resilience in construction management has evolved through distinct thematic stages over the 2012–2026 timeframe. Early research predominantly focused on organizational learning as the primary mechanism for coping with environmental turbulence. Wong and Lam (2012) established that turbulence acts as a powerful catalyst for organizational unlearning, the process of discarding obsolete routines, which is a prerequisite for acquiring new knowledge and restoring operational traction. This early focus, while valuable, treated resilience largely as an internal, learning-oriented cognitive response. The occurrence of the COVID-19 pandemic in 2020 triggered a major theoretical expansion. Faced with a systemic global shock, researchers turned to the dynamic capabilities perspective, framing resilience as a system of integrated capabilities that enable organizations to sense threats, seize opportunities, and reconfigure resources under crisis conditions (Chih et al., 2022; AlMaian & Bu Qammaz, 2023).

More recently, systematic reviews have documented a clear shift away from single-level, siloed, and isolated capability models toward multidimensional, systemic frameworks. Li, Yu, and Deng (2024) analyzed a broad database of articles to trace this evolution, recommending that construction resilience be reconstituted into three core dimensions: structural, operational, and supply-chain resilience. In parallel, researchers have increasingly adopted complexity-aware framings such as the BANI (Brittle, Anxious, Non-linear, Incomprehensible) framework to describe the hyper-turbulent environments in which modern construction projects operate. Under these conditions, individual and team resilience can no longer be viewed as static attributes, but rather as emergent dynamic states that are mediated by social network characteristics, team climate, and resource buffers (Gao et al., 2025; He et al., 2022).

To systematize these theoretical developments and highlight the recent empirical information driving the field, Table 1 provides a comparative matrix of key literature from 2012 to 2026. This comparative matrix classifies the selected studies by their level of analysis, core methodology, temporal focus, and primary academic contributions, establishing a baseline of quality and knowledge for contemporary resilience research.

Table 1: Comparative Matrix of Key Research in Construction Organization Resilience (2012–2026)

Reference	Level of Analysis	Methodology	Key Contributions & Findings	Temporal Focus
Wong & Lam (2012)	Firm	Qualitative Case Studies / Interviews	Established unlearning as a critical mediator. Showed that environmental turbulence triggers unlearning, which in turn facilitates renewed	Reactive / Adaptive

			learning and performance recovery.	
Chih et al. (2022)	Firm	Stock-market Analysis / Reviews	Applied dynamic capabilities (sensing, seizing, reconfiguring) to COVID-19. Created a strategic roadmap linking macro-shocks to organizational survival.	Dynamic (All Phases)
AlMaian & Bu Qammaz (2023)	Firm / Project	Field Research / Practitioner Survey	Linked organizational learning to pandemic survival. Identified key opportunity domains in ICT investment, manager awareness, and standardized business practices.	Reactive & Adaptive
He et al. (2022)	Individual / Team / Project	Social Network Analysis (SNA)	Mapped six employee behaviors (e.g., cohesion, trust) to SNA parameters. Developed a quantitative construction project resilience (CPR) value.	Both (Proactive & Reactive)
Wang, Wu, & Zhang (2022)	Project / Firm / Institutional	Dynamic Configurational Analysis (fsQCA)	Demonstrated that institutional environment dominates proactive preparedness (pre-crisis), whereas resource buffers dominate reactive recovery (post-crisis).	Proactive vs. Reactive
Hua et al. (2025)	Project / Firm	Practitioner Survey / PLS-SEM	Validated a 5-dimension data governance scale (design, standards, collection, storage, application) and linked it directly to project resilience.	Proactive & Reactive
Chen et al. (2024)	Supply Chain	Robust Optimization Modelling	Evaluated backup sourcing and inventory policies under uncertainty. Showed backup decisions are highly sensitive to supplier material and transport costs.	Reactive
Rahi et al. (2025)	Project	Psychometric Scale Validation (EFA/CFA)	Validated a rigorous 9-indicator, 34-item project resilience scale. Provided a standardized instrument for cross-project and empirical benchmarking.	Both (Proactive & Reactive)
Zhao et al. (2023)	Mega-Project / Institutional	Fuzzy Evaluation & fsQCA	Identified institutional environment as the foundational driver of resilience in mega-railway projects. Highlighted supervision and feedback loops as key levers.	Proactive (Preparedness)
Gao et al. (2025)	Team	PLS-SEM & Fuzzy Cognitive Maps (FCM)	Mapped dynamic team resilience under BANI. Proved team climate fully mediates self-efficacy and social support. Simulated rapid vs. long-term interventions.	Both (Proactive & Reactive)
Liu, T., et al. (2025)	Supply Chain	Delphi & Fuzzy Cognitive Maps (FCM)	Identified and ranked 11 critical factors in prefabrication supply chains, placing information exchange and R&D collaboration as top determinants.	Both (Proactive & Reactive)
Aidoo et al. (2023)	Project / Operational	Resilience Analysis Grid (RAG) & Survey	Assessed safety management systems (SMS) in Ghana. Found only 'policy' was resilient, demonstrating failure of conventional safety and need for proactive SMS.	Proactive & Robust

Expanded Geographic and Operational Literature Base

The empirical landscape of construction organization resilience is highly diverse, encompassing various geographical regions, organizational scales, and project types. To ensure that the proposed integrative framework is robust and universally generalizable, we have explicitly expanded and updated our literature base to incorporate international perspectives, particularly focusing on Small and Medium Enterprises (SMEs) and non-mega project environments. Traditional research often exhibits a heavy bias toward capital-intensive mega-projects and large enterprise contexts in highly developed regulatory systems. However, construction industries globally are heavily dependent on fragmented supply chains and smaller firms operating under severe resource constraints.

In terms of geographical and economic diversity, our synthesis integrates critical insights from developing and emerging construction contexts. For instance, Aidoo et al. (2023) evaluated the resilience of safety management systems (SMS) in the Ghanaian construction industry, revealing that traditional, rigid safety compliance frequently fails under the resource constraints of a developing economy. Similarly, Saddique et al. (2023) investigated supply chain transformation in Pakistan, demonstrating that supply chain resilience acts as a vital mediator translating digital supply chain practices into improved firm performance during severe market disruptions. Furthermore, Zungu and Laryea (2024) explored the development of organizational resilience capabilities in South African construction firms, highlighting how localized regulatory challenges, skills deficits, and financial volatility necessitate highly adaptable, micro-level operational practices rather than large-scale, institutionalized systems.

To balance the literature's historical focus on mega infrastructure, we have integrated empirical studies centered on Small and Medium Enterprises (SMEs). Research by Sapeciy et al. (2017, 2019) from a New Zealand practitioner perspective is highly instructive here. The New Zealand construction market is heavily dominated by small and medium-scale enterprises (comprising over 99% of construction firms). Sapeciy et al. (2017) demonstrate that because SMEs lack the financial capital to maintain significant material or redundant inventory buffers, their resilience is primarily relational, relying on localized trust, rapid communication, and informal collaborative networks. These SME contexts show that resilience in smaller firms is not driven by formal governance structures, but by the cognitive flexibility, unlearning capacity, and self-efficacy of individual managers and small, tight-knit project teams.

Finally, by incorporating non-mega project environments, the framework accounts for the micro-level dynamics of standard residential, commercial, and maintenance projects. Empirical work on standard project teams by Gao et al. (2025) and individual employee behaviors by He et al. (2022) provides a vital contrast to mega-project governance (e.g., Zhao et al., 2023; Su et al., 2025). While mega-railway projects depend on highly formal institutional supervision and public accountability loops (Jiang et al., 2024), standard and non-mega projects are heavily influenced by the 'micro-climate' of the project team. Gao et al. (2025) proved that team climate fully mediates the relationship between individual psychological capital (such as self-efficacy and social support) and collective resilience. Similarly, He et al. (2022) demonstrated that standard construction project resilience can be measured and optimized by mapping everyday employee behaviors—such as mutual trust, formal collaboration, and cohesion—onto social network parameters, making resilience management accessible and practical for everyday, non-mega construction operations.

Dimensions and Proposed Integrative Framework

To reconcile the fragmented findings in the literature and provide a unified roadmap for construction management, this paper proposes a layered, multi-dimensional integrative framework of construction organization resilience. The framework is structured around four interlinked domains: (1) Capability Domains, (2) Structural and Institutional Elements, (3) Operational Mechanisms, and (4) Measurement and Indices. Rather than viewing resilience as a static attribute or a singular outcome, this framework conceptualizes it as a dynamic, emergent socio-technical capability that evolves through a temporal lifecycle: preparation, absorption, recovery, and adaptation (Hilu & Hiyassat, 2024). This multi-faceted taxonomy supports both academic diagnostics and strategic managerial intervention.

At its core, the proposed framework relies on three capability domains: organizational learning and unlearning, data governance, and human/psychological resources. Organizational learning and unlearning are critical cognitive drivers, determining how construction organizations interpret shocks and discard obsolete routines in favor of adaptive practices (Jiao & Bu, 2024; Wong & Lam, 2012). Data governance and digital capabilities represent the structural backbone of information, ensuring that raw operational data is synthesized into decision-quality insights (Hua et al., 2025). Human and psychological resources span employee resilience, managerial cognition, and team climate, providing the behavioral and social capital that fuels collective adaptive actions (Wang & Peng, 2024; Gao et al., 2025).

The third domain, structural and institutional elements, provides the formal rules, supervision mechanisms, and contractual guarantees that legitimize resilience actions and stabilize organization-wide behaviors. This institutional environment is particularly critical in mega-projects, where complex stakeholder networks and high public scrutiny require formalized feedback and accountability channels (Zhao et al., 2023). Complementing these structures, the operational mechanisms domain encompasses localized, physical, and digital practices such as supply chain backup sourcing, inventory buffers, and ICT-enabled sensing (Chen et al., 2024; Saddique et al., 2023). Finally, measurement and indices are embedded throughout the framework as observable metrics. By linking subjective, validated survey scales (Rahi et al., 2025) with objective computational evaluation models (Liu & Yuan, 2024), managers can continuously monitor resilience performance and adjust operational levers.

Deepened Critical Synthesis & Theoretical Disagreements

A critical analysis of the construction organization resilience literature reveals several theoretical tensions and contextual differences that shape how resilience is conceptualized, measured, and achieved. Rather than representing a unified, consensus-driven field, our critical synthesis exposes significant theoretical disagreements among researchers, particularly concerning the optimal mechanisms for crisis response and the influence of distinct contextual factors.

The first major theoretical disagreement lies at the intersection of the Resource-Based View (RBV) and Dynamic Capabilities (DC) theory. Adherents of the RBV perspective, such as Chen et al. (2024), argue that construction supply chain resilience is fundamentally anchored in physical and financial resource endowments. Their robust optimization models suggest that maintaining significant inventory buffers, redundant backup suppliers, and flexible backordering capabilities are the most decisive factors for absorbing shocks. Conversely, scholars grounded in Dynamic Capabilities (e.g., Chih et al., 2022; AlMaian & Bu Qammaz, 2023) contend that physical resources represent static, capital-intensive investments that can bleed an organization's profitability during non-crisis periods, which is particularly hazardous for cash-flow-sensitive SMEs. They argue that true resilience is behavioral and cognitive—specifically, the capacity to sense environmental turbulence, rapidly unlearn obsolete routines, and reconfigure existing configurations on the fly (Wong & Lam, 2012). This tension highlights a critical trade-off: RBV emphasizes structural redundancy, whereas DC emphasizes cognitive agility, suggesting that the optimal balance is highly context-dependent.

A second theoretical friction exists between micro-level behavioral perspectives and macro-level structural and institutional models. Micro-level studies (e.g., Wang & Peng, 2024; Mitansha & Potangaroa, 2025) suggest that organizational resilience is an emergent property built from the bottom-up, fueled by individual employee psychological capital, personal coping strategies, and team-level self-efficacy. However, Wang and Peng (2024) identify a major boundary condition: if a construction project's task architecture is highly rigid, fragmented, and siloed, highly resilient individuals who attempt to proactively adapt can generate friction, conflict, and operational sub-optimization across team boundaries. This indicates a structural mismatch where micro-level coping is actively stymied by macro-level contractual or organizational designs, demonstrating that individual psychological resilience cannot be successfully leveraged without corresponding flexibility in formal institutional and task structures.

These theoretical disagreements are strongly moderated by contextual factors, notably project scale and economic development. In mega-projects, the high density of stakeholders, extreme public scrutiny, and regulatory complexity make formal institutional environment the primary driver of proactive preparedness

(Zhao et al., 2023; Su et al., 2025). Proactive resilience here is achieved through highly structured contractual supervision and formalized regulatory feedback channels. In contrast, in standard, non-mega projects and SME operations, formal structures are frequently absent or too costly. Here, informal trust, unlearning capability, and personal relationship quality among project stakeholders serve as the primary stabilizing mechanisms (Sapeciay et al., 2017; Liu et al., 2025). Furthermore, in developing country contexts where institutional rules are weak or volatile (Aidoo et al., 2023), construction organizations rely heavily on informal, relational governance and agile, ad-hoc unlearning of standard operating routines to navigate supply chain gaps (Saddique et al., 2023). Conversely, in developed countries, resilience is increasingly anchored in advanced, formal data governance standards and digital technology applications (Gupta et al., 2026; Hua et al., 2025), which accelerate information velocity and reduce dependence on individualized relationships.

Strengthened Integrative Framework And Feedback Mechanisms

To resolve the fragmentation in the literature, this paper proposes a layered, multi-level integrative framework. The framework organizes construction organizational resilience into four interlinked domains: Capability Domains, Structural/Institutional Elements, Operational Mechanisms, and Measurement/Indices. To strengthen the theoretical validity and practical utility of this framework, we explicitly define the relationships among its core constructs and provide strong theoretical justification, grounded in the Dynamic Capabilities (Sensing, Seizing, and Reconfiguring) perspective, to explain the linkages and feedback mechanisms that operate across micro, meso, and macro levels.

The proposed framework conceptualizes resilience capabilities across three fundamental pillars: (1) Cognitive Pillar (organizational learning and unlearning, driving how organizations interpret and discard obsolete routines); (2) Digital Pillar (data governance maturity across standards, collection, and storage, driving information flow); and (3) Behavioral Pillar (human psychological capital, team climate, and social support, driving collective action). Grounded in Dynamic Capabilities theory, we define three explicit structural relationships among these constructs:

1. Task-Architecture Moderation (Micro-to-Meso Linkage): We theorize that individual behavioral resources (self-efficacy, psychological coping) do not automatically aggregate into organizational resilience. Rather, this linkage is fully mediated by Team Climate (Gao et al., 2025) and strictly moderated by the Task Architecture (Wang & Peng, 2024). When tasks are highly collaborative and structured to facilitate communication, individual psychological resilience is successfully synthesized into collective project resilience, which can be modeled quantitatively via social network centrality measures (He et al., 2022). When task structures are siloed, individual coping mechanisms generate relational friction, inhibiting collective seizing capabilities.

2. Temporal Configural Rules (Meso-to-Macro Linkage): The framework posits that the institutional environment (formal contracts, regulatory supervision) and operational mechanisms (resource buffers, backup sourcing) operate in phase-sensitive, complementary timeframes (Wang, Wu & Zhang, 2022). Institutional elements dominate proactive, pre-crisis preparedness by standardizing safety and communication protocols (Zhao et al., 2023). However, once a shock is absorbed, formal institutional rules must build in 'relational contracting' flexibility to allow managers to bypass rigid regulations and rapidly deploy operational mechanisms (redundant suppliers, backup logistics, financial buffers) for reactive, post-crisis recovery (Chen et al., 2024; Wang, Wu & Zhang, 2022).

3. Vertical Digital Integration (Cross-Cutting Linkage): Data governance capabilities (Hua et al., 2025) act as a vertical accelerant that connects all levels. Standardized data standards and collection protocols directly enhance environmental Sensing. This digital layer accelerates information velocity, allowing top-down institutional mandates to be communicated instantaneously while capturing bottom-up operational feedback from standard project teams (Saddique et al., 2023), particularly in highly vulnerable networks like prefabrication supply chains (Liu et al., 2025).

Crucially, the framework operates as a dynamic, closed-loop system governed by two explicit feedback mechanisms:

1. Measurement-to-Unlearning Feedback Loop: When standardized project metrics (e.g., Rahi et al., 2025's 9-indicator scale) or operational assessments (e.g., Aidoo et al., 2023's Resilience Analysis Grid) identify a vulnerability or sub-standard performance in safety or logistics, this triggers an immediate cognitive signal. This feedback forces the organization to initiate unlearning—the deliberate, active process of dismantling obsolete routines and discarding rigid habits that are no longer effective (Wong & Lam, 2012). This unlearning clears the cognitive space for the organization to engage in experimental learning (Jiao & Bu, 2024), prompting the adjustment of operational buffers and the reinforcement of team-level support.

2. Lifecycle Adaptive Loop: This loop bridges the transition between post-crisis adaptation and pre-crisis preparedness. Following a major shock and subsequent reactive recovery, the lessons learned through trial-and-error experimental learning are codified. This experiential knowledge is formally integrated into updated contract templates, modified regulatory supervision structures (Zhao et al., 2023), and revised data standards (Hua et al., 2025). This institutionalization of post-crisis lessons strengthens the proactive preparedness configurations of future projects, completing the continuous resilience lifecycle of Preparation -> Absorption -> Recovery -> Adaptation.

Empirical Synthesis Of Key Resilience Capabilities And Practices

To operationalize the proposed framework, it is necessary to synthesize the empirical evidence surrounding specific capabilities and practices. The literature highlights three core pillars: (1) Organizational Learning and the cognitive role of unlearning, (2) Data Governance and digitalization, and (3) Human Factors and team climate dynamics. Together, these pillars represent the primary strategic and operational levers available to construction managers.

Organizational Learning, Unlearning, and Managerial Cognition

Organizational learning functions as a foundational capability that shapes how construction firms sense, interpret, and adapt to systemic disruptions. Field research distinguishes between two primary learning modes: acquisitive learning, which focuses on absorbing external best practices and knowledge, and experimental learning, which emphasizes internally generated, trial-and-error adaptation (Jiao & Bu, 2024). Crucially, the translation of these learning modes into actual resilient behaviors is not automatic; it is heavily filtered and mediated by managerial cognition. If managers' mental models are rigid or disconnected from operational realities, even robust learning inputs will fail to produce timely crisis responses, establishing managerial cognitive diagnostics as a vital intervention point.

Furthermore, empirical evidence demonstrates that unlearning is a critical and frequently neglected partner to learning under high turbulence. Wong and Lam (2012) argued that when organizations face severe environmental shifts, they must deliberately unlearn and discard obsolete routines before new, adaptive practices can take root. Turbulence triggers unlearning, which clears the cognitive scaffolding of the firm and permits the rapid acquisition of post-crisis routines, ultimately improving performance under altered conditions. During the COVID-19 pandemic, construction firms with strong organizational learning cultures displayed significantly higher survival rates and were able to capitalize on emergent opportunities. AlMaian and Bu Qammaz (2023) identified that these opportunities concentrated in three interrelated areas: heightened managerial awareness, targeted ICT investments, and the standardization of business practices. This underscores that learning and unlearning are not abstract concepts, but structural capabilities that must be actively cultivated through leadership training and cognitive development.

Data Governance, Digitalization, and Supply Chain Transformation

In the digital era, data governance capabilities represent a critical enabler of sensing and seizing, translating chaotic operational signals into structured, decision-quality insights. Hua et al. (2025) developed and validated a multi-dimensional construct for data governance within construction enterprises, consisting of five core dimensions: top-level design, data standard management, data collection, data storage, and data application. Employing Partial Least Squares Structural Equation Modeling (PLS-SEM) on survey data from industry practitioners, their study demonstrated that weaknesses in any of these dimensions — such as fragmented data

standards, siloed storage, or underutilized analytics — materially blunts a project organization's resilience. Progressive maturity across these five dimensions directly enhances an organization's capacity to detect early warnings, coordinate inter-organizational responses, and make rapid, data-driven decisions under crisis.

Digitalization and supply chain transformation materially alter information velocity and transparency, directly influencing performance under shock. Survey-based empirical work by Saddique et al. (2023) confirmed that supply chain resilience partially mediates the relationship between digital supply chain practices and overall construction performance during crises. By accelerating communication and reducing information latency, digitalization supports tactical operational techniques such as backup sourcing, strategic inventory positioning, and robust multi-period planning (Chen et al., 2024). These technologies are particularly critical in prefabricated construction supply chains. Liu, T., et al. (2025) identified that prefabrication resilience is highly sensitive to information exchange, component performance, and relationship quality. Standardized data platforms enable prefabricated component suppliers and logistics providers to coordinate schedules and technical specifications in real-time, preventing the cascading delays that frequently cripple fragmented, traditional construction supply networks (Liu, T., et al., 2025; Chen et al., 2024).

Human Factors, Team Climate, and Psychological Resources

Socio-technical resilience ultimately depends on the human elements embedded within construction organizations. At the team level, psychological resources and social supports do not operate in isolation; rather, they are channeled through team climate to influence collective resilience. Gao et al. (2025) investigated these dynamics in international construction management teams under Brittle, Anxious, Non-linear, and Incomprehensible (BANI) conditions. Their structural equation modelling (SEM) and fuzzy cognitive mapping (FCM) results revealed that individual attributes such as self-efficacy, cross-cultural adjustment, and social support positively influence team resilience primarily through their positive effect on team climate. Importantly, their simulations showed that while short-term interventions targeting team climate (e.g., norm-setting workshops) produce rapid resilience gains, long-term, sustained high levels of resilience require deep investments in systematic social support and employee well-being.

These psychometric and cognitive insights are strongly reinforced by operational studies in safety-critical environments. In Ghana, an empirical assessment of construction safety management systems (SMS) using a Resilience Analysis Grid (RAG) revealed that traditional, control-oriented approaches fail to cope with project complexity. Aidoo et al. (2023) demonstrated that out of seven evaluated safety elements, only formal policy reached an acceptable level of resilience, indicating that the overall safety systems are not resilient. To build true operational resilience, organizations must transition toward customized, behaviorally informed safety systems that actively engage employee cognition and foster trust. Qualitative work in New Zealand further highlights the necessity of aligning individual psychological coping strategies with formal organizational support structures, confirming that micro-level individual coping and macro-level organizational support are mutually reinforcing (Mitansha & Potangaroa, 2025).

Methodological Landscape And Computational Modelling

A major hallmark of construction resilience research in the 2012–2026 timeframe is its methodological pluralism. The field has rapidly expanded beyond qualitative case studies and descriptive surveys to incorporate sophisticated quantitative, network, and computational modelling techniques. This methodological evolution is driven by the need to translate latent, subjective resilience concepts into calculable metrics and prescriptive decision-support tools. Prominent among these is Social Network Analysis (SNA). He et al. (2022) operationalized construction project resilience (CPR) by mapping six employee behaviors (cohesion, project culture identity, formal behaviors, collaboration efficacy, informal constraints, and mutual trust) onto six network parameters (e.g., density, degree centrality, and betweenness centrality). This network-based approach provides a structured method to calculate a precise CPR value, allowing project managers to identify and target poorly performing employee behaviors to enhance system-level robustness, rapidity, redundancy, and resourcefulness (He et al., 2022).

Heterogeneous-network theory and proactive planning represent a complementary network-based advancement. Śladowski et al. (2024) integrated heterogeneous networks with proactive planning methods to evaluate alternative organizational cooperation strategies and recommend task sequences that optimize risk resilience in complex, socio-technical project environments. For causal modeling and dynamic simulation, Fuzzy Cognitive Maps (FCM) have emerged as a powerful tool. FCMs allow researchers to model the complex, non-linear interdependencies among resilience antecedents and simulate the systemic effects of alternative intervention scenarios (Gao et al., 2025; Liu, T., et al., 2025). Additionally, mathematical optimization and simulation models provide critical prescriptive utility. Chen, Hammad, and Alyami (2024) formulated a multi-period, multi-product supply chain model using robust optimization, proving that backup sourcing and backordering decisions are highly sensitive to alternative suppliers' material prices and transport costs, while inventory holding is an effective hedge against demand volatility. In performance-oriented work, Su, Liu, and Zheng (2025) constructed Labeled Property Graph (LPG) networks and applied genetic-algorithm optimization to enhance Green Construction Performance Resilience (GCPR) in mega-infrastructure projects, illustrating how computational tools can balance resilience and low-carbon objectives.

Systematic Gaps And Future Research Agenda

While the construction resilience literature has made significant empirical and methodological strides, several systematic gaps must be addressed to mature the field. First, there is a pervasive challenge of measurement heterogeneity and a lack of cross-context validation. Although several rigorous scales have been developed — most notably the 9-indicator, 34-item project resilience scale validated by Rahi et al. (2025) — most instruments remain localized, stopping short of broader multi-country or multi-sector validation. This lack of standardization prevents comparable empirical benchmarking and meta-analyses (Rahi et al., 2025; Sapeciay et al., 2019).

Second, there is a structural disconnect between qualitative institutional research (e.g., Zhao et al., 2023) and quantitative algorithmic decision models (e.g., Chen et al., 2024). There is a critical need for mixed-methods research pipelines that translate qualitative institutional rules, supervisory structures, and contract feedback loops into parameterized mathematical constraints for network and optimization models (Wang, Wu, & Zhang, 2022).

Third, empirical research remains characterized by geographic, sectoral, and temporal biases. The vast majority of studies are single-country investigations, often focused on high-profile mega-infrastructure or urban rail transit systems (Liu & Yuan, 2024), which limits generalizability to medium-sized enterprises or developing regulatory environments. Furthermore, despite the theoretical consensus that resilience is a dynamic, multi-phase emergence process (Wang, Peng, & Liu, 2022), longitudinal empirical panels tracking organizations across multiple years and shock cycles remain extremely rare (Chih et al., 2022; Gupta et al., 2026). To resolve these gaps, this paper outlines a five-track prioritized research agenda:

1. Harmonize Measurement Instruments: Establish standardized project and organization level measurement scales, open-access benchmark datasets to support cross-country, cross-jurisdictional validation and comparative meta-analyses (Rahi et al., 2025; Sapeciay et al., 2019).

2. Implement Longitudinal Mixed-Methods Designs: Conduct long-term empirical tracking that combines social network parameters, psychometric surveys, and qualitative process tracing across distinct disaster lifecycles to map the precise emergence and decay curves of organizational resilience (Wang, Peng, & Liu, 2022).

3. Integrate Qualitative Institutionalism with Quantitative Models: Develop analytical pipelines that parameterize qualitative contract rules, stakeholder designs, and supervisory feedback loops into constraints for robust optimization, fuzzy cognitive maps, and agent-based simulation models (Wang, Wu, & Zhang, 2022; Śladowski et al., 2024).

4. Empirical Trials of Data Governance Interventions: Design and execute field trials of data governance reforms (top-level design, standard management, etc.) and integrate them with digital twin technologies to test their causal impact on real-time environmental sensing and decision-making capabilities (Hua et al., 2025).

5. Investigate Cost–Emissions–Resilience Trade-offs: Construct multi-objective optimization models that quantify and balance the financial costs, carbon emissions (green performance), and resilience returns of alternative backup sourcing, material inventory, and procurement policies (Chen et al., 2024; Su et al., 2025).

CONCLUSION

The collective body of construction resilience research published between 2012 and 2026 supports a layered, multi-domain account of organizational survival and adaptation. Building resilience is not a singular investment, but a dual-track strategic process. For proactive preparedness, managers and policymakers must prioritize formal institutional design, stakeholder alignment, contract-embedded supervision, and data governance structures. These mechanisms establish the baseline sensing architectures required to detect threats and coordinate pre-crisis readiness. Conversely, for reactive recovery, organizations must cultivate operational redundancy, calibrated material and financial resource buffers, flexible procurement contracts, and supply chain digitalization. By embedding validated indicator sets and scales into layered, enterprise-wide dashboards, construction organizations can bridge the micro-to-macro divide, converting individual psychological capital and team climate into sustained, project-level adaptive capacity.

REFERENCES

1. Aidoo, I., Fugar, F., Adinyira, E., & Ansah, N. B. (2023). Assessing the level of resilience in construction safety management systems in the Ghanaian construction industry. *Journal of Construction in Developing Countries*, 28(2), 45-67. <https://doi.org/10.21315/JCDC-04-22-0086>
2. AlMaian, R., & Bu Qammaz, A. (2023). The organizational learning role in construction organizations resilience during the COVID-19 pandemic. *Sustainability*, 15(2), 1082. <https://doi.org/10.3390/su15021082>
3. Chen, Z., Hammad, A. W. A., & Alyami, M. (2024). Building construction supply chain resilience under supply and demand uncertainties. *Automation in Construction*, 158, Article 105190. <https://doi.org/10.1016/j.autcon.2023.105190>
4. Chih, Y.-Y., Hsiao, C. Y.-L., Zolghadr, A., & Naderpajouh, N. (2022). Resilience of Organizations in the Construction Industry in the Face of COVID-19 Disturbances: Dynamic Capabilities Perspective. *Journal of Management in Engineering*, 38(4), 04022014. [https://doi.org/10.1061/\(asce\)me.1943-5479.0001014](https://doi.org/10.1061/(asce)me.1943-5479.0001014)
5. Gao, L., Zhang, X., Deng, X., Zhang, N., & Lu, Y. (2025). Using fuzzy cognitive maps to explore the dynamic impact on management team resilience in international construction projects. *Engineering, Construction and Architectural Management*, 32(1), 112-135. <https://doi.org/10.1108/ECAM-08-2023-0828>
6. Gupta, N., Gunawan, I., & Kamineni, R. (2026). Resilience and innovation in the face of disruption: An empirical study of Australia's construction sector. *International Journal of Production Economics*, 292, 109830. <https://doi.org/10.1016/j.ijpe.2025.109830>
7. He, Z., Wang, G., Chen, H., Zou, Z., Yan, H., & Liu, L. (2022). Measuring the construction project resilience from the perspective of employee behaviors. *Buildings*, 12(1), 56. <https://doi.org/10.3390/buildings12010056>
8. Hilu, K. A., & Hiyassat, M. A. (2024). Qualitative assessment of resilience in construction projects. *Construction Innovation*, 24(3), 482-501. <https://doi.org/10.1108/CI-10-2022-0265>
9. Hua, Y., Kang, M., Yao, H., & Fu, Y. (2025). How to foster project organization resilience in the construction industry: The role of data governance capabilities. *Buildings*, 15(8), 1219. <https://doi.org/10.3390/buildings15081219>
10. Jiang, W., Zhao, X., Cai, C., Chang, K., Liu, K., & Liu, Y. (2024). Study on resilience evaluation for construction management of major railway projects. *Buildings*, 14(3), 732. <https://doi.org/10.3390/buildings14030732>

11. Jiao, P., & Bu, W. (2024). The impact of organizational learning on organizational resilience in construction projects. *Buildings*, 14(4), 975. <https://doi.org/10.3390/buildings14040975>
12. Li, J., Yu, H., & Deng, X. (2024). A systematic review of the evolution of the concept of resilience in the construction industry. *Buildings*, 14(9), 2643. <https://doi.org/10.3390/buildings14092643>
13. Liu, T., Ma, L., & Fu, H. (2025). Exploring critical factors influencing the resilience of the prefabricated construction supply chain. *Buildings*, 15(2), 289. <https://doi.org/10.3390/buildings15020289>
14. Liu, W., & Yuan, X. (2024). Research on the resilience evaluation of urban rail transit construction organization based on the cloud matter-element model: A case study of Nanchang West Station. *Buildings*, 14(3), 616. <https://doi.org/10.3390/buildings14030616>
15. Mitansha, M., & Potangaroa, R. (2025). Exploring the interplay between individual and organisational resilience in the construction sector: A comprehensive analysis. *Sustainability*, 17(16), 7229. <https://doi.org/10.3390/su17167229>
16. Rahi, K., Abu Baker, F., Preece, C., & Abu Jadayil, W. (2025). Scale to measure project resilience for the construction sector to cope with hazards. *International Journal of Disaster Resilience in the Built Environment*, 16(1), 124-142. <https://doi.org/10.1108/IJDRBE-04-2023-0058>
17. Saddique, F., Patel, K. R., Niaz, M., Chukwu, M. U., & Nwagwu, U. (2023). Impact of supply chain transformation on supply chain performance: The empirical study that bases on mediating role of supply chain resilience on construction organization on Pakistan. *Asian Journal of Engineering, Social and Health*, 2(9), 118-135. <https://doi.org/10.46799/ajesh.v2i9.118>
18. Sapeciay, Z., Wilkinson, S., & Costello, S. B. (2017). Building organisational resilience for the construction industry: New Zealand practitioners' perspective. *International Journal of Disaster Resilience in the Built Environment*, 8(5), 512-530. <https://doi.org/10.1108/IJDRBE-05-2016-0020>
19. Sapeciay, Z., Wilkinson, S., Costello, S. B., & Adnan, H. (2019). Building organisational resilience for the construction industry: Strategic resilience indicators. *IOP Conference Series: Earth and Environmental Science*, 385, 012068. <https://doi.org/10.1088/1755-1315/385/1/012068>
20. Śladowski, G., Sroka, B., Szewczyk, B., & Barnas, K. (2024). Identification of strategies for enhancing the risk resilience of construction projects as systems. *Automation in Construction*, 166, 105621. <https://doi.org/10.1016/j.autcon.2024.105621>
21. Su, Y., Liu, J., & Zheng, Z. (2025). Enhancing the green construction performance resilience in infrastructure projects: A complexity perspective. *Buildings*, 15(15), 2594. <https://doi.org/10.3390/buildings15152594>
22. Wang, D., Peng, W., & Liu, Y. (2022). The emergence process of construction project resilience: A social network analysis approach. *Buildings*, 12(6), 822. <https://doi.org/10.3390/buildings12060822>
23. Wang, D., Wu, Y., & Zhang, K. (2022). Interplay of resources and institutions in improving organizational resilience of construction projects: A dynamic perspective. *Engineering Management Journal*, 35(3), 215-231. <https://doi.org/10.1080/10429247.2022.2116891>
24. Wang, D., & Peng, W. (2024). Effect of employee resilience on organizational resilience in construction projects: considering the role of project tasks. *Engineering, Construction and Architectural Management*, 31(2), 654-672. <https://doi.org/10.1108/ECAM-08-2022-0797>
25. Wong, P. S. P., & Lam, K. Y. (2012). Facing turbulence: Driving force for construction organizations to regain unlearning and learning traction. *Journal of Construction Engineering and Management*, 138(11), 1251-1259. [https://doi.org/10.1061/\(ASCE\)CO.1943-7862.0000523](https://doi.org/10.1061/(ASCE)CO.1943-7862.0000523)
26. Zhao, X., Liu, Y., Jiang, W., & Wei, D. (2023). Study on the factors influencing and mechanisms shaping the institutional resilience of mega railway construction projects. *Sustainability*, 15(10), 8305. <https://doi.org/10.3390/su15108305>
27. Zungu, Z., & Laryea, S. (2024). Building organizational resilience capacities and capabilities in construction firms. In *Proceedings of the Construction Firm Resilience Conference*, pp. 480-496. <https://doi.org/10.1007/978-3-031-56544-14>