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From Disruption to Competitive Advantage: Strategic Supply Chain Risk Management and the Role of Digital Technologies in Enhancing Operational Resilience

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Abstract - *Today's supply chain world is one of constant volatility, and volatility's ability to render the classic approach to risk management inadequate to begin with, leaving it vulnerable and inadequate in the face of today's fast-paced disruptions and their systemic effects. Although a large body of literature has emerged on both supply chain risk management and digital transformation, on both sides of these literatures, branch-and-bound studies have been conducted without considering the other discipline, resulting in significant gaps in the literature. Despite the huge amount of research on the independent areas of both SCRM and digital transformation, operational resilience and the transformations to sustainable competitive advantage have been researched separately, without overlap in terms of theoretical perspective or underlying meaning. The paper builds on the information processing theory, structural-operational control theory, and the dynamic capabilities view and offers an integrative conceptual framework that provides specific description of how digital technologies enhance and enhance the complexity of strategic supply chain risk management for creating operational resilience and how strategic operational resilience confers competitive advantage in four ways: supply chain integration, logistics excellence, agility and innovativeness, and sustainable value creation. The main arguments of the paper suggest five propositions that can be tested: The moderating impact of digital transformation on innovative changes in supply chains, The mediating effect of information processing capability on the link between digital transformation and innovative changes in supply chains, The centrality of position in the supply chain (SC) network to the innovative changes at the end of the supply chain, Digital transformation's influence on information processing capabilities, Operational resilience as a multi-dimensional dynamic capability. Managing implications of particular investments into a digitalized real-time sensing infrastructure and properly tuning lean-resilient hybrid configurations are highlighted. Towards the end of the article, there are specific implications for future research designs such as structural equation modelling (SEM), longitudinal case studies, agent-based simulation, and the ways these can be used to test the proposed relationships.*

Keywords - *Supply Chain Risk Management; Operational Resilience; Digital Transformation; Disruption Mitigation; Competitive Advantage.*

I. INTRODUCTION

In the past 20 years, the global value chain has dramatically transformed from a linear, cost-efficient system to a highly interconnected and dispersed yet very vulnerable value chain a hyper value chain. This shift has brought about major operational efficiencies and globally unprecedented shifts in markets, but has put organisations at the mercy of an increasing series of disruptions from geopolitical uncertainties, fluctuations in trade policy and pandemic lockdowns through to climate-related catastrophes, failure of cyber-physical systems and supplier financial stress. Tang (2006) pointed out that supply chain risk management needs to move beyond the age-old buffer inventories and single sourcing risk reduction strategies and focus on multiple risk dimensions (strategic, operational and tactical) as risks flow dynamically from one tier to the next in the supply chain and risks are compounded by the very interdependencies that create efficiencies. Despite the significantly greater academic attention that has been focused on identifying, assessing and mitigating risks, there is still a theoretical gap in understanding how contemporary organizations can effectively and systematically engage with digital technologies to do more than just survive “disaster events” but to design and, in the process, architect their supply chain systems to create sustainable competitive advantage.

This is especially a gap because literatures of supply chain risk management, 'Digital Transformation', operational resilience, and 'Competitive advantage' have grown quite independently of each other. In today's ‘smart factories', where the latest Industry 4.0 technologies have entered every node of a supply chain from procurement through production to delivery and service, Vanany et al. (2009) highlighted the need for more future studies to take into account ‘the continuous interplay’ between formal risk management processes and emergent technological innovation. As the coronavirus pandemic proved used, unmatched source of stress, corporations from all across the board had to adopt a fresh look at the now well-known dangers inherent in lean, just-in-time (JIT) supply chain setups that were highlighted by Birkie (2016) and found themselves needing to rethink the compromises among functioning efficiency and structural robustness. At the same time, the digitalization of material flows (AI, big data, transparency through blockchain, IoT and collaborative platforms on the cloud) has been identified as a key ingredient to become a viable catalyst for improved visibility, predictive power and agility of modern supply chains, dramatically impacting the information architecture and decision-making speed of today's material flows. Together with the advances of

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other Industry 4.0 technologies, the individual and combined effectiveness of the technologies reported below have been documented to enhance sensing, seizing, and reconfiguring, the three key dimensions of supply chain resilience, namely: quick recovery speed, severity of impact of disruption, and ability to adapt after disruption (Akbari et al., 2024). Qi et al. (2024) reported that firms with comprehensive digital transformation demonstrate significantly higher performance with respect to supply chain resilience, specifically in terms of quick recovery speed, the severity of impact of disruption, and ability to adapt after disruption.

However, the current literature is lacking when it comes to the systemic interdependencies on which the opportunities for strategic differentiation on supply chain disruptions rely, with pronounced research streams emerging more independently of each other with little regard for the systemic interdependencies. There are some theoretical questions that have yet to be answered, however, and they are all seemingly stupendous. In detail, there are three puzzles left to be solved. Firstly, the information processing theory positing that digital technologies increase the effectiveness of a crisis's risk management process in terms of decreasing information asymmetries (Fan et al., 2017) has not been explicitly described as to how digital sensing would lead to respective changes in structural and/or operational control. First, even though Ivanov and Sokolov (2019) have proved the significance of both the physical dimension of the supply chain configuration and the operational dimension (control parameters) in terms of SCM resilience, the authors' concepts do not apply to the present context with the spread of Industry 4.0 technologies and the increased predictive capabilities provided by digital amplification. Third, from a resource-based view and other supply chain extensions, integrated risk management and digitalisation are seen as valuable, scarce, and hard-to-imitate assets (Mellat-Parast & Spillan, 2014; Bhatnagar & Teo, 2009), but how these capabilities can translate into competitive advantage is not unified across the separate body of literature on integration, logistics, agility and sustainability. This paper discusses this puzzles and proposes an integrative conceptual framework that clarifies the causal mechanisms (potentiality and conditionality) that start with strategic supply chain risk management, combined by the amplification effect of digital technologies, lead to developing operational resilience and then finally to sustainable competitive advantage, creating a coherent theory perspective that enables both practitioners and theory builders to gain a more holistic perspective on how to build resilient supply chains in the face of continuous disruption.

II. Theoretical Foundations: SCRM, Digital Transformation, And The Resilience Imperative

The concept of risks in modern supply chain management is founded on the idea that risk isn't simply something to avoid, reduce, or eliminate, but that risks themselves are a strategic factor that can influence the design, governance, and inter-organizational relationships in a supply chain. Aljabhan (2023) showed that supply chain risk management (SCRM) can enable organizational growth and development when it is well integrated and coordinated with long-term economic strategic planning and the organization's competitive positioning, rather than serving only defensive or compliance functions. Kilubi (2016) sought to capture this richness of risk management and condense these strategies into a few inclusive categories, namely: supply management, demand management, product and process management, as well as information management approaches, to offer some helpful way for organisations to analyse their risk mitigation portfolios systematically and pinpoint their missing parts in their defensive arrangements.
In Fan et al (2017) information processing view, however, a critical issue in classical risk models is that the effectiveness of risk management greatly relies on the ability of an organization to gather, digest, and transmit relevant information in the right manner and at a timely pace, even though that information may exist outside of the organization's boundaries. Theoretically, much of the arc of disruption along the supply chain goes beyond the formidable nature of external shocks; it is caused by the lack of information and communication among players in the network and poor cognitive skills to process and respond to the shocking event. Fan et al. (2017) empirically established a causal sequence as antecedents of RM mechanisms – IP capabilities – operational and financial outcomes on resilience – investments in digital IRs and showed that information processing capability is important for supporting the establishment and activation of RM mechanisms.

TABLE 1. Taxonomy of Supply Chain Risk Management Strategies

Strategy Category	Core Objective	Representative Tactics	Key References
Supply Management	Reduce supplier-related uncertainty and dependency	Multi-sourcing, supplier qualification, collaborative development, strategic alliances	Tang (2006); Kilubi (2016); Aljabhan (2023)
Demand Management	Align supply capacity with volatile demand patterns	Demand forecasting, pooling, postponement, pricing incentives	Tang (2006); Fan et al. (2017)
Product and Process Management	Embed flexibility and robustness into operations	Standardization, modularization, process redundancy, flexible manufacturing	Birkie (2016); Kilubi (2016); Johnson et al. (2021)
Information Management	Enhance visibility and coordination across tiers	Information sharing protocols, digital dashboards, collaborative planning	Fan et al. (2017); Vanany et al. (2009); Chai et al. (2025)
Structural-Operational Control	Optimize network topology and control policies	Inventory positioning, facility location, dynamic routing, real-time reconfiguration	Ivanov and Sokolov (2019); Paul et al. (2017)

The advent of digital technologies has brought about a paradigm shift in how risks are viewed and managed in the supply chain, moving the domain of activities around risk mitigation from after-the-event to risk imaging and the control of the chain. In this paper, Akbari et al. (2024) provide an

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overview of how the nature of digital transformation has evolved in supply chains and summarise the contributions of a range of so-far emerging Industry 4.0 technologies to the sensing, seizing, and reconfiguring aspects of resilient operations the capabilities that directly enable sustainable operations: see Figure 1 of their paper for the technologies. Their results show that digitalisation not only transforms existing processes, but it transforms the information landscape of supply chains as well, providing visibility in depth and into multi-layered supplier networks, real-time market signal-driven dynamic demand forecasting, and autonomous decision-making at supply chain operational nodes means less time lag during disruption events.

TABLE 2. Digital Technologies as Strategic Amplifiers of Supply Chain Risk Management

Technology Domain	Risk Sensing Function	Structural Control Enhancement	Operational Control Enhancement	Resilience Mechanism
Artificial Intelligence and Machine Learning	Predictive risk sensing, pattern recognition, anomaly detection	Dynamic network reconfiguration recommendations	Autonomous production rate adjustments, demand forecasting	Reduces anticipation-to-action latency; enables preemptive rerouting
Big Data Analytics	Disruption signal detection, scenario modeling, network risk mapping	Optimal facility location and inventory positioning under uncertainty	Evidence-based order policy optimization, predictive maintenance	Improves information quality for coordinated multi-tier response
Internet of Things and Cyber-Physical Systems	Real-time asset tracking, condition monitoring, environmental sensing	Automated inventory repositioning across distributed nodes	Trigger-based production scheduling, automated quality control	Provides continuous state visibility enabling real-time structural adaptation
Blockchain and Distributed Ledger Technologies	Immutable transaction audit trails, provenance verification	Smart contract-based supplier qualification and dynamic alliance formation	Transparent multi-tier information feedback loops	Reduces information asymmetry and trust deficits that impede coordination
Cloud Computing and Digital Platforms	Collaborative demand sensing across network partners	Shared network design and capacity planning tools	Cloud-based collaborative planning and resource optimization	Enables ecosystem-level coordination beyond firm boundaries

Li et al. (2024) next explored how this digital maturity manifests in a firm's supply chain management practices, showing that a digitally mature firm is more likely to experience an increase in supply chain integration, process standardization, and cross-functional collaboration; all of which are prerequisite drivers towards achieving effective risk management and are the infrastructure provisions needed for synchronized disruption responses. In a real-world comparison, Qi et al. (2024) discovered that companies that are well-developed in digital transformation have much higher levels of resiliency in their supply chains, which are further supported by other variables: quality of information sharing, level of supply chain operational flexibility, and the extent to which they do collaborate with supply chain partners for innovation.

Chai et al. (2025), from an information improvement and resource optimization point of view, illustrated how digital transformation can help improve transparency by minimising information distortion and latency across different tiers of supply chains, as well as optimising the allocation of resources using data-driven decision support systems (DDS). Lord of the Rings complements the complementary studies of Jiang and Wang (2024), who concluded that enterprise digital transformation helps stabilize the performance of the supply chain by acting as a shock absorber to reduce the transmission of shocks from the nodes in the supply chain, thereby enabling quick reorganization of logistics operations, inventory positioning, and production scheduling. Aslam, Kaushal, and Jain (2025) theorized that digital transformation boosts supply chain resilience via two processes – adaptation and innovation believing that digitally ready organisations have greater dynamic capabilities that can help them reconfigure their supply chain during crisis as well as create new solutions to new problems.

The literature on disruption mitigation also adds grounding; in particular, Kamalahmadi and Parast (2017), among others, studied various available mitigation measures and categorised them based on their temporal orientation as proactive, concurrent, and reactive, concluding that proactive strategies gave the best long term results of resilience when linked to advanced information systems that provide early warning signs, etc. In the past, Paul et al. (2017) have created a quantitative model of forecasting explaining the pivotal importance of real-time information to inform recovery decision-making, and Sudan et al. (2023) have found that real-time data has become a prevalent theme in the current literature on recovery decision-making, with a strong focus on digitally driven recovery and visibility. The authors of Johnson et al. (2021) showed that disruption scenarios for approaches with a focus on robustness and resiliency (that incorporated risk mitigation strategies) beat traditional approaches to supply chain design that focused on minimising costs. Singh and Singh (2019) emphasized the potential for big data analytics to help identify communication failure signals at an early stage, and for algorithms to automatically continuously adapt the risk management process purely based on empirical feedback from the data, rather than drawn from static rules or “heuristics”.

Digital technology advances are helping risk management to become more effective, but an emergent area of concern is how well organizations become operationally resilient and may use digital technologies to deliver on the transformation of their risk management investments into ongoing high performance.

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Galaitsi et al. (2023) gave a comprehensive conceptual analysis of Business Continuity Management (BCM), operational resilience, and organizational resilience, suggesting that the latter and business continuity management are broader concepts than operational resilience, as it focuses on the evolutionary transformation of the organization but has not necessarily reached the level of real-time adaptation that is required to maintain operational resilience of business systems. While the study operational approaches to operational resilience emphasized how the move toward operational resilience will be an evolutionary development beyond the existing practice of operational risk management, Milkau (2021) cast a new light on operational resilience and proposed a framework consisting of three distinct steps institutionalizing proactive risk sensing, developing dynamic capabilities and establishing mechanisms for continuous learning to build operational resilience which goes beyond risk control in compliance mode observations.

Birkie (2016) studied synergies and trade-offs between the lean manufacturing principles and operational resilience and found that lean systems would, by necessity, tend to have lower buffer stocks as a direct result of these manufacturing principles; however, leveraging strategic flexibility, modular process design, decentralising decision-making power, and selecting critical buffers to buffer against shocks, etc can actually make lean more resilient. Together, these three viewpoints make it clear that whether operational resilience is considered as a lack of vulnerability or as a capability is a matter of planning and management of technology, processes, relationships and, ultimately, human resource capabilities through a supply chain network. However, the scientific fragmentation of the cause-and-effect dynamics between digitally amplified risk management, operational resilience, and operational resilience as a competitive advantage. Fragmentation is discussed in the next section through an integrative conceptual model and a series of exportable propositions that delineate the processes, mediators, and contexts that account for these connections.

III. An Integrative Conceptual Framework And Testable Propositions

The core theoretical contribution of this article is the integrative conceptual domain elaborated in this section. The conceptual domain that merges information-processing theory, structural-operational control theory, and the dynamic capabilities view into a coherent causal structure briefly elaborates how digital-amplified strategic supply chain risk management nurtures operational resilience and how it can drive sustainable competitive advantage. The framework differs from previous work on four points: Firstly, it explicitly treats digital transformation as an amplifier, not simply an operational tool, helps to make the structural-operational control mechanisms outlined by Ivanov and Sokolov (2019) more predictive and autonomous rather than reactive, and moves the control into the wider strategic arena. Secondly, it defines information processing capacity as the critical link that connects digital infrastructure with the effectiveness of risk management, which reflects the micro-foundational approach of Fan et al. (2017) and the systems-level approach of Ivanov and Sokolov (2019). Third, it defines operational resilience as a multi-dimensional dynamic capability, not as a single-dimensional outcome, that includes absorptive, adaptive, and regenerative capabilities. Fourth, instead of merely claiming that resilience brings value, it defines four specific tracks to competitive advantage: supply chain integration, logistics excellence, agility & innovativeness, sustainable value creation.

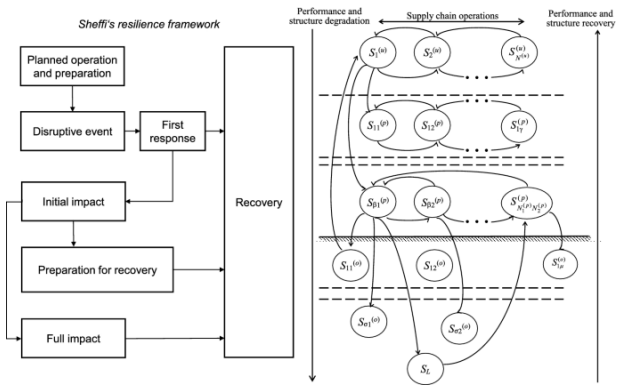

Fig. 1. The Structural-Operational Control Framework for Digital-Enabled Operational Resilience.

The framework outlined in Fig. 1 assumes that perturbations from exogenous events in the supply chain are threats to achieving a stable system. Digital sensing technologies comprise IoT-enabled monitoring, artificial intelligence-based predictive analytics, big data signal detection and cloud-based coordination platforms and watch state variables continuously in two complementary views physical network structures and inventory positioning, facility location, transportation mode and configuration of the network of suppliers and operational control and parameters of the production process and inventory, including production rates, order policies, inventory information feedback loops and demand management protocols. If the disruption signals are above the threshold, the digital control layer activates the rerouting function, the buffer function, and structural changes are activated as well, and in this way, operational resilience is built within the three functions: disturbances are absorbed via automatic rerouting and activation of buffers; core functions continue through configuration of the processes; and the continuous process of learning and network rewiring is regenerative adaptation. From this dynamic control logic would come the first proposition: Out of this dynamic control logic would come the first proposition:

Proposition 1 implies that digital transformation has a positive moderating effect on the relationship between strategic supply chain risk management and operational resilience, and that when digital maturity is higher, the latter has a greater resilience-building effect of investments into SCRM, allowing for reconfiguration of structure and operational processes in real time. Proposition 1 invites digital transformation as a moderating factor; to support this, the empirical results of Aslam et al. (2025) and Qi et al. (2024) showed that digitally mature companies recover more quickly and to a larger extent from disruption relative to less digitally mature companies. The framework introduces one more restriction on this

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"moderation": it is achieved mostly by means of increased ability of information processing. In a study that was published in 2017, Fan et al. researched how information processing capabilities act as a "mediating mechanism" for risk management mechanisms; however, their study did not specifically include digital transformation as an antecedent circumstance. The present framework extends this logic by claiming that digital technologies not only supplement information processing tasks that are already present but sequential and human-backed; they also make such information processing truly continuous, algorithmic, and bring about a real-time reduction of information asymmetries and cognitive restrictions. This results in the second proposition.

The positive relationship between strategic supply chain risk management and operational resilience is mediated by improvements in information processing capabilities, and this mediation effect is stronger under high digital transformation maturity. Chen et al. (2025) presented strong evidence: they found that digitally mature companies are better positioned, more influential, and more connected to their supply chains than other companies, and that this supply chain position is a factor between digitalization and operational resilience. The identification points a finger at digital transformation as not just a process optimization within the organisation, but as a process of reconfiguring network relationships and resource access patterns. Ivanov and Sokolov (2019) also developed a complex theory of simultaneous structural-operational control, proposing that, to maximize resilience benefits, structural and operational controls must be tuned in real time, depending on the severity of the disruption and current state variables found across the network, a capacity that relies exclusively on digital systems of sensing and algorithmic systems of decision-making. Nayal et al. (2024) explored the interactions between AI capabilities and manufacturing strategy options to deliver differential outcomes of resilience, concluding that manufacturers that invest in AI are more likely to experience benefits when they use manufacturing designs with more agile product manufacturing options, such as rapid product changeover, modular process design, and closer integration with suppliers. Together, these views affirm the third statement. When companies hold more central and structurally favorable positions in their supply chain networks, operating resilience would be strengthened by digital transformation, since network centrality would provide leveraged access to resources and information that are needed to respond in a coordinated way to disruptions. Operational resilience, defined in this context, is a multi-faceted mediating capability that converts digitally intensified risk processes into competitive edge. Resilience is seen as a multi-dimensional process ability, a set of three interrelated capacities: absorptive capacity (automated rerouting when something is happening, and rebalancing resources), adaptive capacity (maintaining core functional capabilities when system components are out of order), and regenerative capacity (learning from disruptions and architecturally enhancing the system). It stems from the works of Galaitsi et al. (2023), Milkau (2021), and Birkie (2016), but goes beyond their ideas by integrating these skills into a digital-structural-operational control structure. The framework further indicates that operational resilience can be the source of competitive advantage in four different ways: supply chain process integration and logistics excellence as studied by Mellat-Parast and Spillan (2014), operational agility and innovativeness as explored by Chen (2019), sustainable value creation as explored by Markley and Davis (2007), and collaborative value innovation as explored by Liao et al. (2017). The following is a multi-pathway process that results in the fourth and fifth propositions.

Proposition 4 says operational resilience plays an intermediary role between digital-amplified strategic supply chain risk management and creating sustainable competitive advantage. According to the definition in Proposition 5, operational resilience comes in four complementary ways integration with the supply chain, logistics excellence, market agility and innovativeness, and sustainable value creation, depending on the competitive factors and competitive intensity of the industry. Direct, mediating, and moderating effects should be estimated within a single model of analysis, and the specific empirical operationalization should include structural equation modeling based on multi-source survey data from executives in the supply chain and matched with a set of archival supply chain performance measures. Moderated regression or SEM can be used to test if the relationship between SCRM and resilience is moderated by digital transformation maturity in the case of multi-item scales of digital adoption and resilience outcomes for proposition 1. To study mediation role of information processing capability at the link between the SCRM and the link between the SCRM and the resiliency, the mediation analysis can be conducted by using SEM, and multi-group analysis can be conducted to test the moderated mediation model between the SCRM and the SCRM-resiliency model by dividing them into two subsamples: high and low digital maturity. In the case of Proposition 3, network analysis can be used to quantify the position of the network with a regression model from archives of supplier-customer data or based on self-reported maps of networks by executives. For Proposition 4, SEM with longitudinal panel data can evaluate competitive advantage by different financial and operational performance measures that can be linked. The multi-group SEM or fuzzy-set QCA allows for the identification of configurational pathways, and the cross-industry comparative case studies give information on boundary conditions, namely the clock speed of the industry, the intensity of the regulatory uncertainty, and the complexity of the value chain.

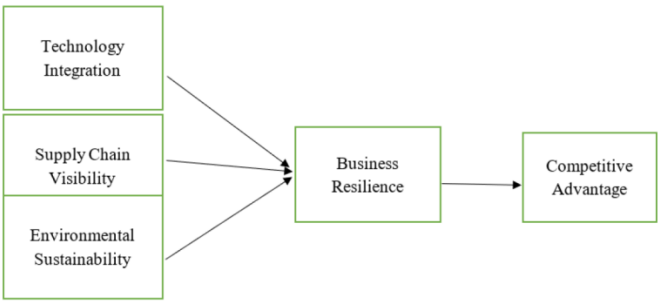

Fig. 2. Integrative Conceptual Framework: From Supply Chain Disruption to Competitive Advantage.

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The overall integrative scheme is shown in Figure 2. Exogenous pressures as identified by Tang (2006) in the form of uncertainties on the supply side, volatilities on the demand side, or unexpected catastrophic environmental events, require strategic responses in terms of risk management for the whole chain, addressing supply management, demand management, and information management issues that were identified by Kilubi (2016) as essential. As noted by Akbari et al. (2024), Li et al. (2024) and Singh and Singh (2019), artificial intelligence, big data analytics, Internet of Things (IoT) connectivity and cloud-based collaboration platforms are key components of a digital transformation architecture that enhances the effectiveness of these strategies. At the same time, digital technologies contribute not only to improving the information processing capacities that are required for the effectiveness of risk management (Fan et al., 2017), but also to the structural and operational control capacities theorized by Ivanov and Sokolov (2019) as essential for dynamic resilience in complex networked systems.

At the core of the framework, we have operational resilience as the ability to withstand disruption via automated rerouting and resource rebalancing, to keep core business functions going through adaptive process reconfiguration as highlighted by Birkie (2016) and Milkau (2021) and to adapt to a future via continual learning and network restructuring as described by Chen et al. (2025) and Nayal et al. (2024). Finally, in terms of generating competitive advantage, operational resilience comes in the ways outlined in Proposition 5. This framework advances theory by connecting four previously disjointed streams of literature into a cohesive theoretical architecture, which gains from the theoretical rigor and depth within each stream, but moves beyond them to provide a more comprehensive explanation regarding the mechanisms, boundary conditions, and feedback of the disruption-to-advantage transformation.

IV. Operational Resilience: Conceptual Boundaries And Digital Amplification

An operational-resilience as an organizational capability needed for a granular examination to understand how it is a mediator in the digital transformation competitive advantage nexus. Operational resilience has to do with the ability of operational systems, processes, and workflows to operate at an acceptable level of performance during disruptions and to quickly recover from a negative event, without losing out on the most important activities that support the creation of value. Galaitsi et al. (2023) contend that it reflects a meso-level capability in an organization that runs between the action/decision of the strategic intent and the actual operation (as opposed to the longer term evolution of the organization towards operational resilience and the planned recovery activities of business continuity). A complementary concept has been offered by Milkau (2021), who argued that operational resilience is an evolutionary step up from operational risk management, as it fosters the development of positive capacities, such as adaptive capacity, orientation to learning, regenerative potential, and dynamic reconfiguration, instead of just the minimization of negative risk axes through control mechanisms and compliance policies. The difference between them could have a big impact on how supply chains are managed to be more resilient and what should be focused on in investing. It raises the question of whether resilience investment should focus on investing in capability building, on investing in developing architectural flexibility, and on investing in human competency building, instead of just investment in loss prevention, investment in insurance, and investment in building redundant assets.

Operational resilience is one key challenge that has been discussed extensively in recent research, and it is clear that an increasing amount of evidence suggests that digitalization provides increased resilience (and operational resilience in particular) via a variety of complementary mechanisms. Chen et al. (2025) offered robust empirical evidence that digitalization can enhance operational resilience by enhancing their SC network position; by creating more central, influential, and well-connected positions within their SC networks, they also gain better access to other critical resources, information, and collaboration during disruption events. This discovery reveals that digital transformation efforts boost resilience as much by changing the way that network relationships, the power dynamic, and resource availability are structured within the firm as by optimizing processes internally to better respond when a firm's main supply streams are disrupted. Ivanov and Sokolov (2019) proposed a high-level theoretical framework which highlights the simultaneous (multi-regulated) structural operational control of supply chain dynamics and supply chain resilience, defining a supply chain in terms of parameters of operational control and physical network structure. Optimal outcomes for resilience depend on structuring and operating the network during the event (particularly in real time) based on the level and nature of the disruptions and the way disruptions propagate through the network; this depends on digital sensing infrastructure, automated systems for collecting data, and iconic decision support systems that can process the huge amounts of network information that would be swamped by human-centric decision-making.

To add to the specificity, Nayal et al. (2024) investigated the different kinds of AI capabilities and how they interact with manufacturing strategy decisions to yield differential resilience outcomes, finding that investments in AI that complement manufacturing strategies that focus on greater operational slack, buffer inventories and collaboration with suppliers were especially significant, whereas in manufacturing systems that relied simply on lean manufacturing, the gains from AI investments were more limited. These perspectives have been theoretically integrated, and such a convergence or integrated group of the three factors – technological ability, embeddedness, and adaptability is seen to enable digital firms to sense disruptions earlier, respond to them faster, and recover from them on a fuller scale compared to non-verifier digital firms. The firms that can effectively develop this integration can withstand disruptions by automatically rerouting and rebalancing traffic around failing nodes, adapt to changing traffic demand and conditions by intelligently utilizing data to guide decisions streamlining processes that depend on manual, hierarchy-driven approvals and procedures to algorithmic optimizations and continuous learning a mindset that translates

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an experience of disruption into an architectural change and capability enhancement. Furthermore, this digitally-infused resilience has been demonstrated through convergent evidence by Aslam et al. (2025) and Qi et al. (2024), resulting in several measurable performance benefits during disruption/disaster events: higher order fulfillment compliance, reduced stockout rates, and quicker return to baseline operations. This conceptualization treats operational resilience as a type of capability by reframing it in terms of the 'Resource-based view tradition,' where it is conceived as a complex, socially embedded, path-dependent routine that is hard to imitate and that can create and contribute to a sustainable competitive advantage when deployed along with complementary digital assets and governance mechanisms.

V. From Resilience To Competitive Advantage: Pathways And Boundary Conditions

In all cases, investments in risk management in the supply chain, digital transformation, and operational resilience have as their ultimate strategic goal the achievement of firm and sustainable competitive advantage in markets that are more volatile, uncertain, complex, and ambiguous. The resource-based view and its extensions suggest that a value, uniqueness, intangibility and lack of substitutability of resources and capabilities are sources of competitive advantage, and within the framework of the theory, a digital supply chain architecture is just such a strategic resource, as its development takes years of investment, learning within an organization and the building of relationships within the chain that is difficult to replicate by competitors. A proposition that was empirically validated by Mellat-Parast and Spillan (2014), who found Logistics and Supply Chain process integration as an important competitive advantage for products, especially when integration refers to aligning with network partners, not only operational synchronization and information sharing but also aligning risk management objectives, performance metrics, and improvement initiatives. They found that companies with high scores in terms of process integration are better than peers in terms of cost efficiency, service quality, delivery reliability, and market responsiveness, showing that the attributes discussed regarding risk management and digitalisation directly benefit the market positioning and customer value creation of companies. Bhatnagar and Teo (2009) were extending this logistics value chain concept to create a holistic framework that makes logistics an important enabler of business competitiveness in international supply chains and demonstrated how a competitive capability extends from a competitive value chain, which now also emphasized the importance of digital tracking, predictive analytics, automated warehousing, and dynamic route optimization in their importance for generating value for business competitiveness, those capabilities allowing to lower lead times, reduce inventory obsolescence, improve assets usage, and increase customer satisfaction through appropriate delivery performance after improved service levels.

Operational resilience boosts competitive advantage, but refers to dynamic capabilities, such as supply chain agility and innovativeness, that enable firms to capitalise on market opportunities during and after disruptions at the industry level, while industry competitors are trying to recover to basic operations. In their study, Chen (2019) built and tested a model that demonstrates how supply chain agility and innovativeness are linked to competitive advantage, and concludes that when indicators of industry stress are present, like customer preferences changing, new regulations or competitors running out of stock, agile supply chains those that contain more fast/quick on-demand products, advanced manufacturing systems, engaged supplier relationships, and modular product architectures are better equipped to recognize and capitalize on fleeting market opportunities. This agility-innovativeness nexus becomes even more significant in the framework of digital transformation, where digital technologies enable coverage of a “playground of information” that, in the dawn of information technologies, is synonymous with latency, distortion, and fragmentation. Markley and Davis (2007) continued the conversation by delving into the concept of the linkages between sustainable supply chain practices and competitive advantage in the future; resilience and sustainability are beginning to merge, and become more so as the risks and vulnerabilities inherent in environmental and social issues are gaining a foothold in the internal logic of strategic planning and supplier selection processes. According to their framework, companies that become resilient through digital and sustainable supply chain management increase their resistance to disruption, establish reputational strengths, gain customer loyalty and gain investors' trust, all of which, in the view of the authors, help them stand out from the mostly less progressive competitors and defend them from price-based competition.

Liao et al. (2017) confirmed this with empirical evidence by analysing how supply chain collaboration, value innovation, and value chain capability influence competitive advantage in the networking communication industry in Taiwan, showing that the influence of supply chain capability development on competitive positioning has an intermediate role between supply chain collaboration, value innovation, and Taiwan's networking communication industry. The model presented in Section 3 builds on this theoretical landscape and integrates all these in a specific sequence as outlined, as a conceptual approach that explains the transformational process from disruption exposure to competitive advantage. From practitioners' perspective, it suggests that in the modern world, to achieve competitive advantage it is no longer enough to have a competitive cost or weighted competitive diff. capabilities; one must now develop the systematic capabilities in the digital supply chain, some of which are resilient and can transform any kind of unavoidable disruption into a new opportunity for strengthening the network, for building capabilities, and for re-positioning. But the framework also recognizes the boundary conditions: the relative importance of each competitive advantage pathway depends on the speed of the clock in the industry, intensity of regulation, supply chain complexity and national culture; this means that this is not a “one size fits all” compute that firms must install on their resilience investments to attain competitive advantage, but rather, tailor their investments based on their specific competitive context.

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VI. Conclusion, Managerial Implications, and Future Research Directions

In this paper, a broad theory of the strategic evolution of supply chain risk management from defense-resistant and compliance-based operations to a proactive and digitally facilitated capability to create operational resilience and sustainable competitive advantage has been presented, which assumes constant environmental volatility. By summarising related literature about the foundations of supply chain risk management, technologies of digital transformation, concepts of operational resilience, and mechanisms for winning competitive advantage, the research illustrates that an integrative approach from all four key disciplines (supply chain risk management, information technology, operations, and competitive advantage) is essential so that the businessman can understand the interdependencies between different elements of the supply chain. The study demonstrates that strategic supply chain risk management produces operational resilience to respond quickly and effectively to structural and operational risks when driven by digital technologies that boost information processing, visibility of networks, and autonomous decision-making. Operational resilience, in turn, plays a key role as a dynamic capability that supports the link between risk management and digital investments on the one hand and the generation of competitive advantages through value creation and supply chain integration, on the other hand, as well as the generation of operational agility, innovativeness in the supply chain, and sustainable value creation that is differentiated from the opposition.

In the rest of this section it is possible to outline the following implications to managers and supply chain practitioners which directly support the propositions listed in Section 3: To begin with, digital transformation investments ought not merely to be efficiency-driven or be a part of the mundane and after-the-thought automation One-Off, but rather specifically aim at implementing imban architectures for real-time sensing infrastructure, including IoT enabled monitoring, AI based prediction, cloud enabled, multi-tier visibility platforms. From the framework and Proposition 1, it is deducible that a digital investment can create better resilience returns than simply automating transactional processes by investing instead in the fraud sensing and response capabilities. Secondly, operational resilience should not be assigned as a second-line responsibility to operational managers, but must be built and firmly established in strategy, as a major strategic goal that is board-level managed, has dedicated budget, and is cross-managed by stakeholders. This institutionalization will involve creating more flexible process designs, various “polyvalent” staffing options and cross-training strategies, supplier collaboration and business development programs, and good faith redundancy in the supply pathways that do not fit into the classic application of business continuity planning. Third, managers need to understand that the concept of resilience and efficiency need not be mutually exclusive ways of emphasizing one target or the other, but rather can be achieved through hybrid systems, which combine lean system thinking and resiliency strategies (specifically Buffers, Modular Process Design, Flexible Capacity) without compromising on either cost discipline for market competitiveness or adaptive capacity for disruption survival as detailed in Proposition 2. Fourth, competitive advantage is not only possible - let alone realized - by achieving high operational levels within the internal firm; managers should also seek to strengthen the relational embeddedness of the firm within structured position in the digitally integrated supply network and with network members, through collaborative platforms, risk-governance shared between them, and joint programs of capability enrichment, to strengthen the overall ecosystem's capacity to overcome shocks and stresses, as argued in Proposition 3.

Despite these contributions, this type of research does have its limits, which further suggest possible fruitful paths for future research. The conceptual integrative framework and testable propositions to be developed later in Section 3 need to be extensively empirically supported. Testing of Propositions 1–5 should be carried out in the future through the use of multi-source survey data of supply chain executives coupled with archival performance data (both these data would be gathered on a sample of supply chain executives), and analyzed with the use of structural equation modeling (SEM); this would allow all of the direct, mediating and moderating effects to be estimated from an integrated analytical model. Second, longitudinal case studies, following the process of digital SCRM implementation and adoption over at least three years, would shed light on how the digital SCRM capability is built over time and how the process of making structural and operational control adjustments evolves during disruptions.

Finally, agent-based simulation experiments could be conducted under different levels of digital maturity and network topologies for each supply chain, to determine the best structure-operational control setting for getting the best resilience results, while at the same time minimizing the overall cost of the supply chain. Fourth, multi-group structural equation modeling or cross-national comparative case studies of the industry clock speed, regulatory intensity, supply chain complexity, and national culture as specified in Proposition 5 need to be explored to determine contextual contingencies for the salience of specific competitive advantage pathways. Finally, even though this paper has all too often illuminated the bright side of digital technologies to build supply chain resilience, scholars can and should explore the dark side of digitalisation: cyber security challenges where the digitally integrated network may be subject to novel systemic risks from data security threats, data privacy issues that may prevent the sharing of information across organisational boundaries and algorithms that can produce algorithmic bias and amplify, rather than mitigate, disruption in automated supply chain decisions. Continued and multi-disciplinary research in this vein can help develop a better understanding of how companies can adapt to an age of permanent change and emerge intact and, indeed, well prepared, and enjoying unique assets their rivals will not be able to quickly emulate.

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