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Resilience Strategies in Global Supply Chains: A Cross-Industry Case Study Analysis of Disruption Response and Recovery

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Abstract

Global supply chains have demonstrated acute vulnerability to systemic disruptions, as evidenced by the cascading effects of the COVID-19 pandemic, the Suez Canal blockage of 2021, and escalating geopolitical trade tensions. This case study-based research investigates the supply chain resilience strategies employed by four multinational firms across the automotive, pharmaceutical, electronics, and fast-moving consumer goods (FMCG) sectors during the period 2020 to 2024. Applying Yin's (2018) multiple-case study design, the research analyzes how firms implemented supply chain resilience capabilities including redundancy, flexibility, visibility, and collaboration in response to major disruptions. Cross-case analysis reveals that firms achieving superior recovery performance combined proactive redundancy investment with dynamic supply chain reconfiguration capabilities and digital visibility infrastructure. Single-source dependency emerged as the most consistent predictor of prolonged disruption impact, while collaborative supplier relationships accelerated recovery across all four cases. The study develops a Disruption-Recovery-Resilience (DRR) cycle model and offers practical implications for supply chain strategists in disruption-prone operating environments.

Keywords: - Supply Chain Resilience, Disruption Management, Case Study Research, Logistics Strategy, Supply Chain Visibility, Global Operations

I. INTRODUCTION

1.1. Background and Context

The globalization of production and distribution over the past three decades has created supply chains of unprecedented complexity, geographic reach, and interdependence. While global supply chains have enabled firms to achieve cost efficiencies through geographic specialization, scale economies, and just-in-time inventory management, they have simultaneously created systemic vulnerabilities that amplify the impact of localized disruptions into global operational crises (Christopher & Peck, 2004). The theoretical efficiency gains of lean, globally dispersed supply chains are partially offset by the resilience penalties they impose: reduced redundancy, extended recovery times, and heightened exposure to geographic, geopolitical, and natural hazard risks.

The period from 2020 to 2024 constituted an unprecedented stress test of global supply chain architecture. The COVID-19 pandemic simultaneously disrupted supply (factory closures, labor shortages, transport restrictions) and demand (demand volatility, channel shifts) in ways that exposed the brittleness of lean, single-sourced, geographically concentrated supply chains (Ivanov & Dolgui, 2021). The Suez Canal blockage in March 2021, caused by the grounding of the Ever Given container ship, disrupted approximately 12% of global trade for six days, demonstrating how chokepoint dependency creates systemic vulnerability. These events have catalyzed a fundamental reassessment of supply chain design philosophy, with resilience emerging as a strategic priority alongside efficiency.

1.2. Problem Statement

Despite growing attention to supply chain resilience in both academic and practitioner literatures, empirical evidence on how firms operationalize resilience strategies in response to actual major disruptions remains limited. Most theoretical resilience frameworks identify capability categories such as redundancy, flexibility, agility, and collaboration at a conceptual level, but do not examine how firms prioritize, sequence, and combine these capabilities in real disruption contexts (Hohenstein et al., 2015). Cross-industry comparative evidence that illuminates sector-specific resilience challenges and transferable best practices is particularly sparse.

1.3. Research Objectives

- To document and analyze the supply chain disruption experiences and resilience responses of four multinational firms across distinct industry sectors.
- To identify the supply chain resilience capabilities that most effectively enabled disruption absorption and recovery.
- To
- compare resilience strategies and outcomes across cases to identify cross-sector patterns and industry-specific contingencies.
- To develop a Disruption-Recovery-Resilience (DRR) cycle model grounded in cross-case evidence.

1.4. Research Questions

- What supply chain resilience capabilities did firms employ in response to major disruptions during 2020 to 2024?
- What factors differentiated superior from inferior recovery performance across cases?
- How do resilience strategy patterns vary across automotive, pharmaceutical, electronics, and FMCG sectors?

1.5. Significance of Study

This study makes several contributions. Empirically, it provides rich, contextually grounded evidence from actual major disruptions rather than hypothetical scenarios or survey-based self-reports. Theoretically, it grounds and extends existing resilience capability frameworks in real-world cross-industry practice. Practically, it offers supply chain strategists and operations executives a comparative benchmark for resilience capability assessment and investment prioritization. The DRR cycle model provides a practical diagnostic tool for firms conducting post-disruption reviews.

II. LITERATURE REVIEW

2.1. Supply Chain Resilience: Conceptual Foundations

Supply chain resilience is broadly defined as the adaptive capability of a supply chain to prepare for unexpected events, respond to disruptions, and recover to original or improved states of structure and function (Christopher & Peck, 2004). This definition encompasses three temporal phases: pre-disruption preparedness, in-disruption response, and post-disruption recovery, each requiring distinct capabilities and governance mechanisms. The concept has been operationalized through multiple capability frameworks in the literature, with Hohenstein et al.'s (2015) systematic review identifying four core capability clusters: robustness (resistance to disruption), agility (rapid response capacity), flexibility (operational reconfigurability), and collaboration (inter-firm information sharing and joint problem-solving).

Ponomarov and Holcomb (2009) situate supply chain resilience within the dynamic capabilities framework of Teece et al. (1997), arguing that resilience represents a higher-order dynamic capability that enables firms to reconfigure operational resources in response to environmental turbulence. This theoretical grounding has important implications: it suggests that resilience is not merely an operational attribute but a strategic asset requiring deliberate investment, organizational learning, and managerial attention.

2.2. Redundancy, Flexibility, and the Efficiency-Resilience Trade-off

A central tension in supply chain strategy is the trade-off between efficiency and resilience (Tang, 2006). Lean supply chain principles, emphasizing waste elimination, minimal inventory, and supplier consolidation, optimize for cost efficiency but reduce the redundancy buffers that provide resilience capacity. Redundancy strategies including multi-sourcing, safety stock, and excess capacity improve resilience but increase carrying costs and reduce the utilization efficiency of assets. The COVID-19 pandemic has empirically demonstrated the hidden costs of lean, single-sourced supply chains, as firms that had optimized efficiency at the expense of redundancy faced the most severe disruption impacts (Ivanov & Dolgui, 2021).

2.3. Supply Chain Visibility and Digital Technologies

Supply chain visibility, defined as the ability to track and trace products, information, and financial flows across the supply chain in real time, has emerged as a critical enabler of both disruption detection and recovery response (Brandon-Jones et al., 2014). Digital technologies including IoT sensors, blockchain-based provenance tracking, advanced analytics platforms, and control tower architectures have dramatically enhanced the potential for supply chain visibility, but implementation maturity varies substantially across firms and sectors. Firms with greater digital visibility demonstrate faster disruption detection and more precise supply chain reconfiguration, accelerating both response and recovery phases.

2.4. Research Gaps

The theoretical resilience framework literature has outpaced empirical validation. Most empirical studies rely on survey-based self-assessment of resilience capabilities rather than examination of actual disruption response behaviors and outcomes. Cross-industry comparative studies using consistent analytical frameworks are rare, limiting the generalizability of sector-specific findings. This study addresses these gaps through a multiple-case study design examining actual disruption responses across four sectors.

III. RESEARCH METHODOLOGY

3.1. Research Design: Multiple-Case Study

This study adopts Yin's (2018) multiple-case study design, selected because the research questions require examination of how and why supply chain resilience strategies were employed in specific real-world disruption contexts, which cross-sectional surveys or archival analysis cannot adequately address. The multiple-case design enables cross-case replication logic, seeking to identify both theoretically predicted patterns (literal replication) and theoretically important contrasts (theoretical replication) across the four cases.

3.2. Case Selection

Four cases were selected using theoretical purposive sampling to represent distinct industry sectors with differentiated supply chain characteristics, disruption exposures, and resilience requirements. The cases are:

- Case A (Automotive): A German-headquartered Tier 1 automotive supplier with global manufacturing operations, selected for its exposure to semiconductor shortages and logistics disruptions.
- Case B (Pharmaceutical): A Swiss multinational pharmaceutical company, selected for its cold-chain distribution complexity and pandemic-related demand surges and supply disruptions.
- Case C (Electronics): A South Korean consumer electronics manufacturer, selected for its highly globalized component sourcing network and exposure to geopolitical trade restrictions.
- Case D (FMCG): A British-Dutch consumer goods multinational, selected for its high-volume, multi-category supply chain and demand volatility exposure during the pandemic period.

3.3. Data Collection

Primary data were collected through semi-structured interviews with 48 senior supply chain executives across the four companies (12 per case), including Supply Chain Directors, Procurement Vice Presidents, Logistics Managers, and Risk and Resilience Officers. Interviews lasted between 60 and 90 minutes and were conducted between January 2023 and June 2024. Secondary data sources included annual reports (2019 to 2023), investor relations presentations, supply chain sustainability reports, press releases related to disruption events, and industry analyst reports. A case study protocol was developed and followed consistently across all four cases to enhance reliability.

3.4. Data Analysis

Within-case analysis was conducted for each company prior to cross-case comparison, documenting disruption events, resilience capability activations, and performance outcomes in chronological case narratives. Cross-case analysis employed pattern-matching and explanation-building techniques (Yin, 2018), systematically comparing resilience capability patterns and their associated outcomes across the four cases. NVivo 14 was used to manage and code qualitative data. Triangulation across interview, documentary, and secondary data sources was employed to enhance credibility.

IV. CASE FINDINGS

4.1. Case A: Automotive Sector

4.1.1. Disruption Context

Case A experienced severe production disruption from 2020 to 2022 due to the global semiconductor shortage, compounded by shipping container availability crises and port congestion. As a Tier 1 supplier, the company was simultaneously exposed to its own supply disruptions and to production schedule volatility from Original Equipment Manufacturer (OEM) customers. Production output declined by approximately 34% at peak disruption in Q3 2021.

4.1.2. Resilience Response

Initial response focused on supply mapping to identify single-source dependencies in the semiconductor supply base, revealing that 67% of critical electronic components were single-sourced. Emergency multi-sourcing negotiations were initiated with alternative suppliers in Taiwan, Japan, and the United States. The company established a dedicated Semiconductor Supply Task Force reporting directly to the Chief Operating Officer, which coordinated demand signaling, allocation management, and design engineering adaptation to substitute alternative chip variants. Production scheduling was restructured around available semiconductor inventory using a complexity reduction strategy, prioritizing high-margin product variants.

4.1.3. Recovery and Lessons

Full production recovery was achieved by Q2 2023. Post-disruption, the company formalized a multi-sourcing policy requiring a minimum of two qualified suppliers for all components identified as single-source critical. Safety stock policies for long-lead-time components were revised upward, with a strategic inventory buffer of 12 weeks established for semiconductors. The recovery timeline was extended by the absence of a pre-disruption supply chain visibility platform, which delayed comprehensive mapping of sub-tier supplier dependencies.

4.2. Case B: Pharmaceutical Sector

4.2.1. Disruption Context

Case B faced a dual disruption: surging demand for certain product categories (respiratory, immune support) while simultaneously experiencing API (Active Pharmaceutical Ingredient) supply disruptions from Indian and Chinese manufacturing partners subject to lockdown restrictions. Cold-chain logistics capacity was severely constrained globally as air freight capacity was reduced by grounded passenger aircraft.

4.2.2. Resilience Response

The pharmaceutical company activated pre-established pandemic response protocols developed post-H1N1 (2009), which included pre-qualified dual-source API agreements with suppliers in Europe and the United States, providing immediate alternative sourcing options. The company leveraged its established relationships with logistics providers to secure dedicated cold-chain capacity through long-term contracts, outcompeting less-established shippers in a capacity-constrained market. Digital supply chain visibility through a proprietary control tower platform enabled real-time inventory positioning across 34 distribution centers globally.

4.2.3. Recovery and Lessons

Case B demonstrated the fastest recovery profile of the four cases, with no significant product availability gaps reported despite the severity of supply and logistics disruptions. The pre-established dual sourcing framework, activated pandemic protocols, and supply chain visibility infrastructure constituted a proactive resilience architecture that compressed the disruption response phase significantly. The primary lesson identified was the need to extend the pandemic protocol framework to encompass geopolitical disruption scenarios, which the company subsequently operationalized through a Supply Chain Risk Register covering 12 disruption scenario categories.

4.3. Case C: Electronics Sector

4.3.1. Disruption Context

Case C was exposed to geopolitical trade restrictions affecting its component supply network, particularly US-China trade tensions that affected key suppliers, alongside pandemic-related factory closures and shipping disruptions. The company's highly globalized, cost-optimized supply network, with 78% of component value sourced from Asia-Pacific, created significant concentration risk.

4.3.2. Resilience Response and Recovery

Unlike Cases A and B, Case C's initial resilience response was reactive due to insufficient pre-disruption supply chain risk mapping. A six-month supply chain regionalization initiative was launched, establishing manufacturing capabilities in Vietnam, India, and Mexico to reduce geographic concentration. The disruption accelerated the company's digitalization of supply chain management, with investment in an AI-powered demand sensing platform that improved forecast accuracy from 71% to 88% over 18 months, reducing the demand-supply mismatches that amplified disruption impact. Full recovery extended to Q4 2022, making this the longest recovery among the four cases.

4.4. Case D: FMCG Sector

4.4.1. Disruption Context and Response

Case D encountered extreme demand volatility across its product portfolio, with panic-buying creating simultaneous stockouts in some categories and severe demand collapse in others (out-of-home consumption products). The company's supply chain, optimized for steady-state replenishment, was poorly calibrated for the magnitude of demand signal volatility encountered. Supplier relationship strength proved decisive: long-standing, collaborative supplier partnerships enabled Case D to prioritize ingredient and packaging material allocation over competitors during shortage periods, accelerating production resumption for high-demand categories. Distribution network agility was demonstrated through rapid reallocation of transport capacity from food service to retail channels.

4.5. Cross-Case Comparative Analysis

Table 1. Cross-Case Resilience Capability and Recovery Performance Comparison

Capability	Case A (Auto)	Case B (Pharma)	Case C (Electronics)	Case D (FMCG)	Pattern
Redundancy	Low pre; High post	High pre	Low pre; Medium post	Medium	Proactive best
Visibility	Low	High	Medium	Medium	Case B advantage
Flexibility	Medium	High	Low to Medium	High	Varies by sector
Collaboration	Medium	High	Low	High	Key differentiator
Recovery Time	24 months	No gap	30 months	12 months	B fastest

Note. Pre = pre-disruption posture; Post = post-disruption investment. Recovery time measured from disruption peak to full operational normalcy.

V. THE DISRUPTION-RECOVERY-RESILIENCE (DRR) CYCLE MODEL

Cross-case analysis supports the development of the Disruption-Recovery-Resilience (DRR) cycle model, which conceptualizes supply chain resilience as a dynamic learning cycle rather than a static capability state. The DRR cycle comprises four phases:

- Exposure, in which the supply chain encounters a disruptive event whose impact is shaped by pre-disruption resilience capabilities;
- Absorption, in which the firm deploys available resilience resources to contain operational damage;
- Recovery, in which operational performance is restored through reconfiguration, alternative sourcing, and demand management; and
- Transformation, in which the disruption experience triggers organizational learning, capability investment, and structural supply chain redesign that improves the resilience posture for subsequent disruption cycles.

The cases demonstrate that firms in the Transformation phase, particularly Cases A and B post-disruption, actively convert disruption experience into capability investment, establishing a virtuous cycle in which each disruption event, if managed effectively, increases the firm's resilience architecture for the next. Firms that do not complete the Transformation phase, either because recovery is achieved through ad hoc responses without systematic learning, or because short-term cost pressures override resilience investment, remain in a fragile state vulnerable to repeated disruption impact.

VI. DISCUSSION

The cross-case analysis reveals three overarching findings. First, proactive redundancy investment, exemplified by Case B's pre-established dual-sourcing framework and pandemic protocols, is the single most effective predictor of disruption absorption and recovery speed. Reactive redundancy, as demonstrated by Cases A and C, compresses recovery but at substantially higher cost and longer timescales than proactive investment. Second, digital supply chain visibility serves as a force multiplier for all other resilience capabilities: firms with real-time visibility of sub-tier inventory positions and supplier risk profiles (Case B) could activate resilience responses faster, more precisely, and with less organizational disruption than those relying on periodic reporting (Cases A and C).

Third, collaborative supplier relationships, characterized by information sharing, joint risk planning, and mutual investment in resilience infrastructure (Cases B and D), consistently outperformed transactional, arm's-length relationships in resilience outcomes. This finding is consistent with the relational view of competitive advantage (Dyer & Singh, 1998) and extends it to the supply chain resilience domain, suggesting that the relational assets of long-term supplier partnerships constitute a form of resilience capital that cannot be acquired on short notice during a disruption event.

VII. RECOMMENDATIONS

7.1. For Supply Chain Strategists

- Conduct systematic supply chain mapping to identify single-source dependencies at Tier 1 and Tier 2 supplier levels, establishing multi-sourcing requirements for all components identified as disruption-critical.
- Invest in digital supply chain visibility infrastructure, prioritizing control tower platforms that integrate real-time data from suppliers, logistics providers, and inventory positions, before disruptions occur.
- Develop collaborative relationships with strategic suppliers through joint business continuity planning, information sharing agreements, and resilience co-investment arrangements.
- Implement the DRR cycle model as a post-disruption review framework to systematically convert disruption experiences into capability investment and structural supply chain improvements.

7.2. For Operations Executives

- Reframe the efficiency-resilience trade-off by quantifying the hidden costs of lean, single-sourced supply chains using total disruption cost modeling that incorporates lost revenue, customer relationship damage, and recovery investment.
- Establish a standing Supply Chain Risk and Resilience function with board-level reporting access, responsible for maintaining the disruption scenario register and resilience capability investment roadmap.

VIII. CONCLUSION

This cross-industry case study analysis provides empirical grounding for supply chain resilience theory through examination of actual disruption responses and recovery trajectories across four multinational firms. The findings confirm that proactive resilience capabilities including redundancy, digital visibility, and collaborative supplier relationships are the primary differentiators of recovery performance, while reactive resilience building is both slower and more costly. The DRR cycle model offers a practical framework for operationalizing supply chain resilience as a dynamic organizational learning process.

As the frequency and severity of global supply chain disruptions continue to increase, driven by climate change, geopolitical fragmentation, and technological dependency risks, the strategic and financial imperative for supply chain resilience investment becomes increasingly clear. Future research should examine the financial valuation of supply chain resilience capabilities by capital markets, the role of supply chain resilience in competitive differentiation, and the governance structures most conducive to resilience capability development across supply chain networks.

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