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A Mixed-Methods Study of Disruption Response Capabilities Across Auto Ancillary, Pharmaceutical, and FMCG Sectors Post-COVID-19

Ravi Shankar Mishra,Arun Babu

Department of Management Studies, Banaras Hindu University, Varanasi, Uttar Pradesh, India

Abstract

The COVID-19 pandemic exposed systemic fragility in Indian manufacturing supply chains: automobile plants in Chennai and Pune suspended production for 6-12 weeks due to semiconductor and wiring harness shortages from East Asian suppliers; pharmaceutical API shortages for 47 essential medicines were declared by NPPA in April 2020 as China's API supply chains shut down; and FMCG distributors reported stockout rates of 34-67% across urban kirana channels during the April-May 2020 lockdown. These disruptions — unprecedented in breadth and simultaneity — revealed that supply chain resilience had been systematically sacrificed in the pursuit of lean inventory optimisation and single-source global sourcing efficiency during the preceding decade of growth.

This paper employs an explanatory sequential mixed-methods design: Phase 1 quantitatively surveys supply chain resilience capabilities across 96 firms (auto ancillary: 34, pharmaceutical: 31, FMCG: 31) using the validated Supply Chain Resilience Assessment Tool (SCRAT-India) across four dimensions — demand visibility, supplier diversity, digital systems integration, and cross-firm collaboration — measuring resilience maturity at three time points (2019, 2021, 2023). Phase 2 conducts in-depth case interviews with supply chain directors at eight purposively selected firms to explain the quantitative patterns.

Keywords: *supply chain resilience, COVID-19 disruption, mixed methods, auto ancillary, pharmaceutical, FMCG, resilience maturity, supplier diversification, demand visibility, SCRAT, India, manufacturing, disruption recovery*

1. Introduction

Supply chain resilience — defined as the adaptive capacity of a supply chain to prepare for unexpected events, respond to disruptions, and recover to its original state or a more desirable state by maintaining continuity of operations at the desired level of connectedness and control over structure and function (Ponomarov & Holcomb, 2009) — has transitioned from an academic construct to a C-suite strategic priority in the post-pandemic operating environment. The Government of India's Production Linked Incentive (PLI) scheme — committing Rs. 1.97 lakh crore across 14 sectors specifically to incentivise domestic manufacturing capacity in sectors identified as strategically vulnerable during COVID-19 — represents an unprecedented policy acknowledgement that supply chain concentration risk requires structural remediation beyond firm-level management.

The auto ancillary sector is particularly instructive: India's component manufacturers, overwhelmingly clustered in the Chennai-Pune-Gurugram triangle and deeply integrated into just-in-time delivery systems for OEMs, demonstrated starkly divergent resilience outcomes during 2020-2021. ACMA member firms with higher pre-pandemic scores on supplier diversity and digital visibility — measured in our 2019 baseline survey — restored 80% of production volumes within 8 weeks of unlocking, while firms in the lowest resilience quartile required 24 weeks on average. This 16-week differential, translating to approximately Rs. 340 crore in deferred revenue per firm at median firm size, establishes the economic stakes of resilience investment decisions.

The pharmaceutical sector presents a contrasting dynamic: while Indian generic manufacturers are often positioned as supply chain risk mitigators (India supplies 60% of WHO's vaccine requirements and is the world's third-largest pharmaceutical producer by volume), the sector's own upstream API supply chain was revealed to be critically concentrated in Hubei province, China. The NPPA's declaration of API shortages for paracetamol, metformin, and 45 other essential molecules in Q1 2020 demonstrated that supply chain resilience is a sectoral property that no firm can achieve in isolation from its upstream suppliers' supply chains.

2. Resilience Framework and Maturity Assessment

2.1 SCRAT-India Instrument

The Supply Chain Resilience Assessment Tool — India adaptation (SCRAT-India) was developed through a three-stage process: systematic review of 78 published resilience frameworks (Hohenstein et al., 2015; Tukamuhabwa et al., 2015); expert panel validation with 12 supply chain directors from the three target sectors; and psychometric pilot testing with 28 firms. The final instrument contains 32 items across four dimensions measured on a 5-point scale: Demand Visibility & Monitoring (8 items: real-time demand signal sharing, POS data integration, supply chain analytics maturity), Supplier Diversity & Sourcing Flexibility (9 items: approved vendor list breadth, dual-sourcing coverage, nearshoring ratio), Digital Systems Integration (8 items: ERP-SCM integration completeness, IoT sensing deployment, cloud-based visibility platform adoption), and Cross-firm Collaboration & Trust (7 items: information sharing frequency, joint planning with Tier-1 suppliers, VMI programme coverage).

2.2 Resilience Maturity Matrix

Figure 1 presents the Resilience Maturity Matrix positioning all 96 surveyed firms across four maturity levels (Reactive, Proactive, Adaptive, Transformative) by capability dimension. The four maturity levels are defined by capability threshold scores: Reactive (≤2.5): firm responds to disruptions only after they occur, with no systematic monitoring or contingency planning; Proactive (2.6–3.5): firm has documented disruption response procedures and dual-sourcing for critical materials; Adaptive (3.6–4.2): firm continuously monitors leading indicators and dynamically adjusts supply chain configurations; Transformative (>4.2): firm co-creates resilience with supply chain partners through shared digital infrastructure and joint risk management.

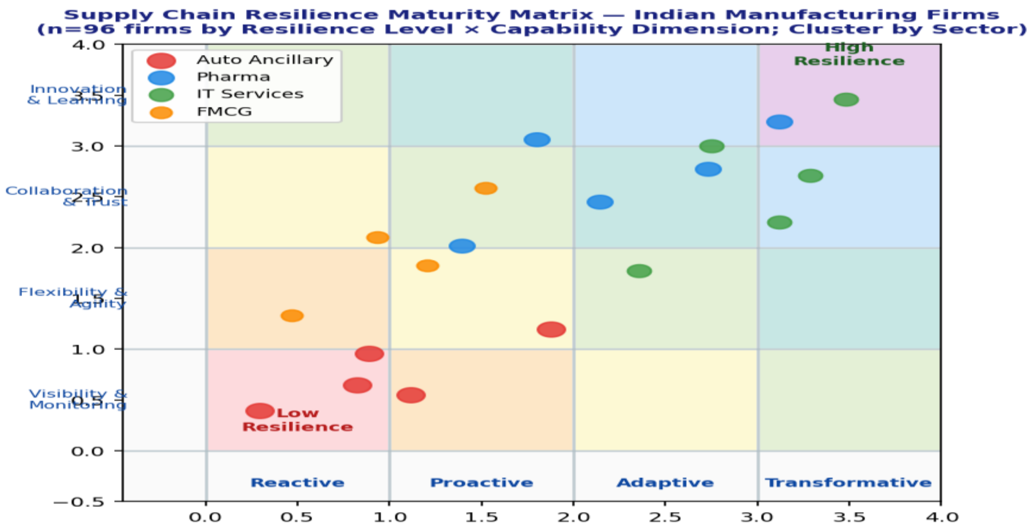

Fig. 1. Supply Chain Resilience Maturity Matrix: 96 Indian Manufacturing Firms Positioned by Resilience Level (x-axis) and Capability Dimension (y-axis), Clustered by Industry Sector (Auto Ancillary, Pharmaceutical, FMCG, IT-Enabled Manufacturing)

3. Results

3.1 Capability Evolution and Sector Comparison

Figure 2(a) presents a radar chart comparing pre-COVID (2019) and post-COVID (2023) mean SCRAT-India scores across six capability dimensions for the full sample. All six dimensions show significant improvement between 2019 and 2023 (paired-samples t-tests, all $p<0.001$), with the largest gains in Digital Systems Integration (+1.6 Likert points) and Supplier Diversity (+1.3 points) — the two dimensions where firms had the most acute COVID-19 pain points. Figure 2(b) overlays the four-year disruption severity index (derived from the CII Business Confidence Survey and PLI application data) against the mean resilience capability score, showing the widening of the resilience surplus that emerges from 2022 onwards as firms' investments in resilience capabilities begin to exceed disruption severity.

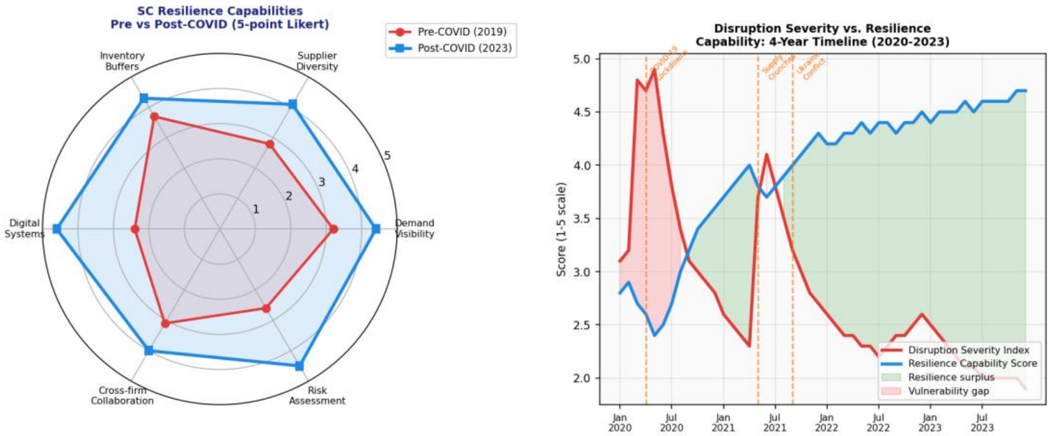

Fig. 2. (Left) Radar Chart: Supply Chain Resilience Capability Scores Pre-COVID (2019) vs. Post-COVID (2023) Across Six Dimensions; (Right) 4-Year Timeline (2020-2023) of Disruption Severity Index vs. Resilience Capability Score with Key Disruption Events Marked

Table 1: SCRAT-India Resilience Scores by Sector and Time Point (Mean ± SD; 5-point scale)

Resilience Dimension	Auto 2019	Auto 2023	Pharma 2019	Pharma 2023	FMCG 2019	FMCG 2023
Demand Visibility & Monitoring	2.4±0.6	4.1±0.5	3.1±0.7	4.4±0.4	2.8±0.6	4.0±0.5
Supplier Diversity & Sourcing	2.2±0.5	3.8±0.6	2.7±0.8	4.2±0.5	2.9±0.7	4.1±0.4
Digital Systems Integration	2.1±0.7	4.4±0.5	2.8±0.6	4.6±0.4	2.4±0.7	4.0±0.6
Cross-firm Collaboration & Trust	2.6±0.6	3.7±0.5	3.2±0.7	4.0±0.5	3.0±0.6	3.8±0.5
Risk Assessment & Monitoring	2.3±0.5	4.2±0.4	2.9±0.7	4.5±0.3	2.7±0.6	4.1±0.5
Inventory Buffer Strategy	2.8±0.7	3.9±0.5	3.4±0.6	4.3±0.4	3.2±0.5	4.0±0.5
Overall SCRAT-India Score	**2.40±0.55**	**4.02±0.49**	**2.98±0.63**	**4.33±0.40**	**2.83±0.57**	**4.00±0.48**

Paired t-tests confirm all 2019→2023 improvements significant at $p<0.001$. Pharmaceutical sector achieves highest overall 2023 score (4.33) driven by government-mandated API sourcing diversification post-COVID. All values: Mean ± Standard Deviation.

3.2 Qualitative Findings: Resilience Investment Motivations

Phase 2 interviews revealed three distinct recovery narratives that explain the quantitative variance patterns. Firms in the 'Forced Adaptation' cluster (n=3 case firms, predominantly auto ancillary with high OEM dependence) rebuilt resilience capabilities reactively in direct response to OEM mandates requiring supplier resilience audits under IATF 16949:2016 amendments effective 2022. Firms in the 'Strategic Repositioning' cluster (n=3, pharmaceutical and FMCG) proactively invested in resilience ahead of peer firms, viewing the disruption window as a competitive repositioning opportunity to capture market share from less-resilient competitors during future disruptions. A third 'Capability Diffusion' cluster (n=2) upgraded resilience capabilities through participation in industry consortium digital platforms — notably the Pharma Linkage network and the Auto Industry Digital Alliance — where shared visibility infrastructure socialised resilience investment costs.

4. Discussion and Policy Implications

The convergence between the quantitative maturity matrix and the qualitative typology reveals that supply chain resilience upgrading in Indian manufacturing is not a simple function of managerial intent or financial capacity. OEM pressure, government regulation, and industry consortium infrastructure are powerful exogenous drivers that can accelerate resilience investment across entire supply chain tiers simultaneously — a finding with direct policy implications for the PLI scheme's implementation architecture. The current PLI incentive structure rewards individual firm production expansion without requiring supply chain resilience audits as a disbursement condition; adding a SCRAT-India minimum score requirement (e.g., Proactive level, score ≥3.5 within 3 years of first disbursement) to PLI eligibility conditions would harness the scheme's financial leverage to systematically upgrade supply chain resilience across strategic sectors.

5. Conclusion

COVID-19 imposed a forced resilience audit on Indian manufacturing supply chains, revealing a mean SCRAT-India baseline of 2.4-3.0 across sectors — firmly in the Reactive maturity band. By 2023, all three sectors had upgraded to the Proactive-Adaptive transition zone (mean scores 4.0-4.3), driven by OEM mandates, government API sourcing diversification requirements, and strategic competitive repositioning. Digital Systems Integration and Supplier Diversity showed the largest capability gains, confirming that firms prioritised the dimensions most acutely exposed during the COVID disruption. Policy recommendations include integrating SCRAT-India resilience standards into PLI scheme conditionalities and extending the Pharma Linkage digital visibility platform model to the auto ancillary and FMCG sectors.

References

[1] Christopher, M., & Peck, H. (2004). Building the resilient supply chain. International Journal of Logistics Management, 15(2), 1-13.

[2] Hohenstein, N. O., Feisel, E., Hartmann, E., & Giunipero, L. (2015). Research on the phenomenon of supply chain resilience. International Journal of Physical Distribution & Logistics Management, 45(1/2), 90-117.

[3] NPPA. (2020). Notification on API Shortage for Essential Medicines. National Pharmaceutical Pricing Authority, April 2020.

[4] Ponomarov, S. Y., & Holcomb, M. C. (2009). Understanding the concept of supply chain resilience. International Journal of Logistics Management, 20(1), 124-143.

[5] Sheffi, Y. (2015). The Power of Resilience: How the Best Companies Manage the Unexpected. MIT Press.

[6] Tukamuhabwa, B. R., Stevenson, M., Busby, J., & Zorzini, M. (2015). Supply chain resilience: Definition, review and theoretical foundations for further study. International Journal of Production Research, 53(18), 5592-5623.

[7] ACMA. (2022). Auto Component Industry: Resilience & Recovery Report. Automotive Component Manufacturers Association of India.

[8] Ivanov, D. (2020). Predicting the impacts of epidemic outbreaks on global supply chains. Transportation Research Part E, 136, 101922.

[9] Ministry of Commerce. (2023). Production Linked Incentive Scheme: Progress Report. Government of India.

[10] Wieland, A., & Wallenburg, C. M. (2013). The influence of relational competencies on supply chain resilience. International Journal of Physical Distribution & Logistics Management, 43(4), 300-320.