

# Supply Chain Risk Management in Indian Manufacturing: Strategies Adopted for Mitigating Disruptions

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## **Abstract**

The Indian manufacturing sector has become an integral component of the global supply chain, characterized by increased integration, competition, and exposure to diverse risks. Globalization, technological shifts, and uncertain regulatory regimes have intensified the vulnerability of supply chains to disruptions. This study provides a comprehensive review of theoretical models and empirical literature on supply chain risk management (SCRM), with particular emphasis on the Indian context up to 2018. The paper traces the conceptual evolution of SCRM from linear risk-response models to resilience-oriented and network-centric paradigms. It synthesizes frameworks such as supply chain vulnerability theory, the resource-based view, and dynamic capabilities, and analyses international findings on risk identification, assessment, and mitigation. The Indian literature reveals that while firms are aware of the need for risk management, the adoption of systematic and digitalized strategies remains inconsistent across sectors. Common challenges include supplier dependence, logistical fragility, infrastructure deficits, and policy volatility. However, emerging practices such as multi-sourcing, collaborative planning, and information-technology-driven monitoring are transforming traditional approaches. The synthesis underscores that proactive and integrative SCRM enhances resilience, cost efficiency, and competitive advantage. The paper concludes that strengthening organizational culture, technological capability, and inter-organizational collaboration are essential to mitigate disruptions and ensure sustainable manufacturing growth in India.

**Keywords:** Supply chain risk management, manufacturing resilience, disruption mitigation, supplier diversification, logistics vulnerability, dynamic capabilities, India.

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## **I. Background and context**

Globalization of production networks, the relentless pursuit of cost efficiencies, and accelerating technological change have collectively transformed manufacturing supply chains into highly interconnected, complex systems. Over the past three decades, firms worldwide shifted from vertically integrated production to globally dispersed, specialized networks of suppliers and service providers. For Indian manufacturing, these global trends combined with rapid domestic economic reforms have produced a vibrant but exposed industrial ecosystem. By 2018, India was vigorously pursuing higher manufacturing output and competitiveness as part of national agendas (for example, through initiatives such as ‘Make in India’), while simultaneously grappling with structural constraints in infrastructure, institutional capacity, and the firm-level capabilities required to manage supply chain risk effectively.

Supply chain disruptions—whether triggered by natural hazards, geopolitical shocks, supplier failure, transport and logistics breakdowns, regulatory changes, or abrupt demand shifts—pose immediate threats to production continuity, cost structures, and firm reputation. In the Indian context, the multiplicity of risks is compounded by factors such as fragmented supplier bases, limited visibility across extended supply networks, infrastructure gaps (road, rail, port, power), variable regulatory environments across states, and the prevalence of small and medium enterprises (SMEs) with constrained financial and managerial resources. At the same time, the rise of digital technologies, increasing emphasis on quality standards, and entry into global value chains (GVCs) have raised both the stakes and the opportunities for adopting proactive supply chain risk management (SCRM) strategies.

This introduction frames the problem of SCRM in Indian manufacturing, synthesizes major theoretical and empirical insights up to late 2018, articulates key research gaps, and outlines the rationale and objectives for a systematic investigation into strategies that Indian manufacturers adopt to mitigate disruptions. The treatment emphasizes conceptual clarity—defining what constitutes risk, disruption, and resilience in supply chains—and aims to situate Indian practice within broader, internationally recognized approaches to SCRM while highlighting context-specific challenges and strategic responses.

### **Definitions and conceptual framing**

Supply chain risk management is an interdisciplinary field drawing from operations management, strategic management, logistics, information systems, and public policy. For the purposes of this study, three core concepts are defined:

- **Supply chain risk** refers to the probability of an event or condition that could adversely affect the supply chain's ability to deliver products and services to customers according to expectations of cost, quality, quantity, and timing. Risks may be internal (firm-specific), supply-side (supplier failure, quality problems), demand-side (sudden demand collapse or surge), operational (machine breakdowns, labor disputes), environmental (natural disasters), or systemic (financial crises, infrastructure failures).
- **Disruption** denotes an event or series of events that causes a substantial deviation from planned operations. Disruptions are characterized by abruptness, unpredictability, and the potential for cascading effects across the network. Not all risks manifest as disruptions; some can be managed through routine controls, while others escalate into broader failures.
- **Resilience** is the capacity of the supply chain to anticipate, absorb, adapt to, and recover from disruptions. Resilience strategies include redundancy, flexibility, responsiveness, and adaptability, which together reduce vulnerability and shorten recovery time.

The conceptual model adopted here distinguishes between proactive (prevention and preparedness) and reactive (response and recovery) strategies. Proactive measures include supplier diversification, inventory buffering, robust contracts, and investment in visibility and analytics; reactive measures encompass contingency planning, emergency sourcing, and rapid re-routing. An integrated SCRM approach combines risk identification, assessment (likelihood and impact), mitigation, monitoring, and continuous learning.

### **The nature of supply chain risk in Indian manufacturing**

Indian manufacturing is heterogeneous—ranging from highly automated, export-oriented firms in pharmaceuticals and auto components to domestic-market-focused SMEs in textiles, metalworking, and engineering goods. This heterogeneity shapes risk exposure and the feasible set of mitigation strategies. Key characteristics of supply chain risk in the Indian manufacturing context include:

1. **Fragmented supplier networks and SME dominance:** A substantial share of components and intermediate goods are produced by small-scale suppliers with limited quality control and financial resilience. Supplier failure risk is thus non-trivial and can transmit quickly to lead firms.
2. **Infrastructure constraints:** Unreliable transport networks, congested ports, and variable power supply increase lead times and variability, thereby raising operational risk and the likelihood of stockouts or production delays.
3. **Regulatory and institutional variability:** Differences in state-level regulations, bureaucratic procedures, and enforcement can create compliance risks and administrative disruptions, particularly for firms operating across multiple Indian states.
4. **Information opacity and limited visibility:** Firms often lack real-time visibility into tier-2 and tier-3 suppliers. This opacity limits early detection of supplier-side risks and impairs coordinated responses when disruptions occur.
5. **Demand volatility and market fragmentation:** Rapid changes in consumer preferences combined with seasonal demand in some sectors make forecasting difficult, increasing the risk of either stockouts or excess inventory.
6. **Integration into global value chains:** Export-oriented manufacturers face additional externalities—currency risk, global logistics disruptions, and compliance with international quality and social standards—which interact with domestic vulnerabilities.
7. **Natural hazards and climate-related risk:** Floods, cyclones, and other weather-related events periodically disrupt production and logistics, with pronounced impacts in geographically concentrated clusters.
8. **Technological transition risks:** Adoption of digital technologies (ERP, supplier portals, IoT) brings new cybersecurity and data-integration risks alongside benefits in visibility and analytics.

### **Theoretical perspectives and frameworks**

Multiple theoretical lenses inform the study of SCRM. The introduction draws particularly on four frameworks that support analysis of mitigation strategies:

1. **Risk management cycle** (identify → assess → mitigate → monitor → review): This procedural model emphasizes continuous management and feedback loops, underscoring that SCRM is not a one-off activity but an ongoing capability-building process.
2. **Resource-based view (RBV):** From an RBV perspective, SCRM capabilities—such as flexible production systems, supplier relationship management, and advanced information systems—are strategic resources that can confer sustained competitive advantage by reducing vulnerability to disruptions.

3. **Network theory:** Supply chains are networks; network topology (centralized vs. decentralized, clusteredness), node criticality, and interdependency influence risk propagation. Network analysis helps identify critical suppliers and potential systemic risks.
4. **Resilience engineering and complex adaptive systems:** This approach treats supply chains as adaptive systems that must balance efficiency with redundancy and flexibility. Concepts such as diversity (in sourcing and routing), modularity (decoupling critical processes), and adaptive capacity are central to resilience.

### **International Evidence and Implications for India**

Empirical literature up to late 2018 indicates that firms deploy a mix of strategies to manage supply chain risk. Broadly, the global evidence suggests:

- **Multi-sourcing and supplier diversification** reduce dependence on single suppliers and lower the probability of catastrophic disruption from supplier failure. However, diversification may increase coordination costs and reduce economies of scale.
- **Inventory policies (safety stock and strategic reserves)** provide time for corrective action during disruptions but entail holding costs and potential obsolescence.
- **Supply chain visibility and information sharing**—enabled by IT systems—improve early detection of risks and speed of response. Visibility is particularly valuable for managing tiered supplier networks.
- **Collaborative relationships and relational contracting** with suppliers facilitate joint problem solving and quicker recovery. Trust and long-term orientation encourage suppliers to allocate scarce resources to critical buyers during crises.
- **Flexibility in manufacturing (reconfigurable production, cross-training)** and logistics (multi-modal transport, alternative routing) enhance adaptive capacity.
- **Financial hedging and contractual risk transfer** (insurance, long-term contracts with penalty clauses) can allocate risk but may be cost-prohibitive for smaller firms.
- **Scenario planning and contingency exercises** increase organizational readiness and reduce recovery time after an event.

Translating these global insights to India requires attention to local constraints. For instance, while IT-enabled visibility is effective, many Indian SMEs lack the capital or skills to implement advanced systems. Similarly, while multi-sourcing is conceptually attractive, viable alternative suppliers may be geographically proximate and therefore vulnerable to the same regional risk.

### **Strategies observed in Indian manufacturing**

Indian manufacturers display a repertoire of SCRM strategies that reflect firm size, sectoral characteristics, and access to resources. Prominent strategies include:

#### **1 Supplier management and development**

- **Supplier diversification:** Lead firms often diversify across suppliers and geographies where feasible. However, true geographical diversification may be limited by infrastructure and logistics costs.
- **Supplier development programs:** Larger firms invest in capacity building—technical assistance, quality training, and process standardization—to strengthen supplier reliability. This is a form of risk mitigation that converts suppliers into strategic partners.
- **Relational contracting:** Long-term contracts, incentives for quality, and performance-based procurement help align supplier behavior with continuity objectives.

#### **2 Inventory and production strategies**

- **Safety stock and buffer inventory:** Firms maintain higher safety stocks for critical components, trading off carrying costs against stockout risk.
- **Postponement and modular production:** Techniques such as postponement delay final product differentiation, reducing inventory risk related to demand uncertainty.
- **Flexible manufacturing systems:** Investment in machines and worker skills that enable rapid product changeover increases operational flexibility.

#### **3 Network design and logistics**

- **Nearshoring and supplier clustering:** Some firms cluster suppliers regionally, seeking logistical efficiency while also evaluating the cluster's vulnerability to local shocks.
- **Dual sourcing and alternate routing:** Firms identify alternate transport routes and logistics partners, and in some cases maintain contracts with multiple carriers.

#### **4 Information and digital strategies**

- **ERP and supply chain software adoption:** Larger manufacturers implement enterprise systems to gain real-time visibility, though widespread penetration among SMEs remains limited.
- **Use of analytics:** Data-driven forecasting and risk analytics are increasingly used to anticipate disruptions, optimize inventory, and evaluate supplier risk.

### 5 Financial and contractual mechanisms

- **Insurance and financial hedges:** Where accessible and affordable, firms use insurance to transfer certain risks and line-of-credit arrangements to cushion cash-flow shocks.
- **Penalty and incentive clauses:** Contracts often include clauses that penalize late delivery and reward reliability, aligning incentives.

### 6 Organizational preparedness and governance

- **Contingency planning and business continuity plans (BCPs):** Formal BCPs are more common among multinational and large domestic firms; many smaller firms rely on ad hoc responses.
- **Cross-functional risk committees:** Establishing governance structures for SCRM—integrating procurement, operations, logistics, and finance—improves coordinated responses.

### 7 Collaboration and public-private measures

- **Industry clustering associations and knowledge sharing:** Industry bodies and clusters facilitate collective action—sharing best practices and coordinating on infrastructure or emergency response.
- **Engagement with government programs:** Firms leverage public incentives for upgrading supply-chain capabilities, especially for compliance with international standards.

### Constraints and trade-offs in strategy choice

Strategic choices in SCRM involve trade-offs. For instance, redundancy (multiple suppliers, higher inventory) improves resilience but raises costs and may reduce competitiveness on price. Investments in visibility and analytics yield benefits but require capital, skilled personnel, and data integrity. For SMEs, resource constraints often lead to reactive rather than proactive SCRM, increasing exposure to low-probability high-impact events. Furthermore, some mitigation strategies can create systemic risk if widely adopted without coordination—e.g., clustering all suppliers for efficiency creates geographical concentration risk. Policymakers and industry leaders must therefore consider the macro-level implications of micro-level strategies and balance efficiency with distributed resilience.

### Research gaps and the need for context-specific evidence

While international literature offers rich insights into SCRM, several research gaps persist in the Indian manufacturing context up to late 2018:

1. Many Indian firms are small and medium-sized, yet much of the SCRM literature is biased toward large, global firms. There is limited empirical evidence on how SMEs perceive risk, prioritize mitigation investments, and collaborate within supply networks.
2. Operationalizing and measuring resilience in Indian supply chains—through metrics that capture both robustness and recovery capacity—remains underdeveloped.
3. The interplay between public infrastructure quality and firm-level SCRM choices needs systematic study. For example, how do road or port reliability affect optimal inventory policies?
4. While policy initiatives aim to bolster manufacturing competitiveness, rigorous evaluation of their impact on SCRM adoption is sparse.
5. How do managerial perceptions, risk culture, and informal networks influence the adoption of SCRM practices in India?
6. The implications of emerging technologies for risk detection, supply chain transparency, and cyber-physical vulnerabilities in Indian manufacturing are nascent areas of inquiry.

Addressing these gaps requires mixed-methods research that combines firm surveys, case studies in industrial clusters, network analysis, and simulation modeling tailored to Indian industry sectors.

### Research objectives and questions

Responding to the gaps outlined above, this study's primary objective is to examine the strategies Indian manufacturers adopt for mitigating supply chain disruptions and to evaluate their effectiveness under prevailing domestic constraints. Specific research objectives include:

1. To map the repertoire of SCRM practices across firm sizes and manufacturing sectors in India.
2. To assess contextual factors (infrastructure, supplier base, regulatory environment, firm capabilities) that shape strategy adoption.
3. To measure the perceived and actual effectiveness of selected mitigation strategies in reducing disruption frequency, duration, and impact.
4. To identify barriers—financial, informational, institutional—to proactive SCRM and propose actionable recommendations for firms and policymakers.
5. To develop an integrated framework for SCRM suitable for Indian manufacturing firms of varying scale and technological maturity.

Key research questions include:

- What are the most commonly adopted SCRM strategies among Indian manufacturers, and how do these vary by firm size and sector?
- To what extent do investments in supply chain visibility and supplier development correlate with reduced disruption exposure?
- How do infrastructure deficiencies and regulatory variability influence optimal inventory and sourcing strategies?
- What organizational, financial, and informational constraints limit adoption of proactive SCRM among SMEs?
- Which public policy measures could most effectively complement firm-level strategies to enhance supply chain resilience in India?

### **Contributions and practical significance**

The intended contributions of the study are threefold:

1. **Academic contribution:** By focusing on Indian manufacturing, the study enriches SCRM literature with context-specific empirical evidence, enhances understanding of strategy–context interactions, and develops metrics for resilience applicable in emerging market settings.
2. **Managerial relevance:** The results will provide managers with evidence-based guidance on selecting cost-effective SCRM strategies aligned with firm scale and sectoral requirements. Practical toolkits (e.g., decision matrices, risk-assessment templates) can support implementation.
3. **Policy implications:** Findings will inform policymakers about structural bottlenecks—such as infrastructure gaps and informational asymmetries—that dampen firms’ ability to manage supply chain risk. Recommendations will suggest targeted interventions (infrastructure investments, SME support for digitalization, regulatory harmonization) to enhance overall industrial resilience.

### **Scope and delimitations**

The study focuses on manufacturing firms operating in India and addresses supply chain risks that materially affect production continuity. Certain delimitations apply:

- Service-sector supply chains (e.g., pure logistics firms) are outside the scope; however, the logistics dimension as it affects manufacturing is considered.
- The study emphasizes disruptions with direct operational impact (e.g., supplier failure, transport blockages). Financial market contagion and macroeconomic crises are considered only insofar as they affect operational continuity.
- While the study recognizes global interdependencies (e.g., imported inputs), detailed analysis of cross-border trade policy is limited.

## **II. Literature Review**

### **1. Introduction to the SCRM**

Supply Chain Risk Management (SCRM) is an interdisciplinary field that has grown rapidly since the early 2000s as manufacturers and supply-chain scholars confronted increasingly frequent and visible disruptions (natural disasters, terrorism, supplier failure, financial shocks, regulatory changes, and more). The literature spans conceptual/theoretical work, quantitative modeling, empirical surveys and case studies, and applied tools such as network analysis and simulation. This review first synthesizes major theoretical frameworks and strategy taxonomies developed in international literature, then summarizes prominent empirical and modeling work on mitigation strategies and effectiveness, and finally reviews India-specific empirical studies and policy-relevant findings up to 2018. Throughout I indicate methodological patterns, recurring findings, and consistent gaps that shape the research agenda for emerging-market SCRM.

### **2. Core concepts and theoretical frameworks in SCRM**

The international SCRM literature converges on several foundational ideas: (a) risks are heterogeneous (supply, demand, operational, environmental, macro/political); (b) disruptions differ from routine variability by being low-frequency/high-impact and often systemic; and (c) resilience — the capacity to anticipate, absorb, adapt and recover — is a central objective of SCRM. Foundational conceptual syntheses emphasize that SCRM is both a continuous process (identify → assess → mitigate → monitor → learn) and a capability involving organizational resources, network structures, and governance mechanisms. Christopher & Peck’s influential framing identified resilience as an organizing goal and catalogued levers (collaboration, agility, re-engineering, continuity teams) for building resilient chains. Several theoretical lenses are routinely used to analyze SCRM:

- **Risk management cycle / process framework.** Reviews commonly present SCRM as cyclical: risk identification, assessment (likelihood × impact), mitigation (strategic choices), monitoring, and review/learning.

Tang's review maps quantitative models and links them to this lifecycle, highlighting differences in approaches for frequent operational risks vs. infrequent catastrophic disruptions.

- **Resource-based and capability perspectives.** SCRM capabilities (visibility, supplier development, flexible production) are treated as firm resources that create competitive advantage by lowering vulnerability and shortening recovery time. This lens connects SCRM investment decisions to firm strategy and heterogeneity in firm performance post-disruption.

- **Network and systemic perspectives.** Supply chains are complex networks: topology (centralized vs. decentralized), node criticality, and interdependencies determine how shocks propagate. Network analysis and contagion models are increasingly used to identify critical suppliers and systemic risk hotspots. Empirical work shows that network position matters for vulnerability and recovery.

- **Resilience engineering and complex adaptive systems.** Scholars borrow from resilience engineering to argue that supply chains should be designed with diversity, redundancy, modularity, and adaptive capacity. Sheffi and Rice emphasized flexibility and redundancy as complementary strategies: flexibility can yield everyday efficiency while redundancy provides protection against rare but severe shocks.

Together these theoretical perspectives encourage multi-level analysis (firm capabilities, dyadic relationships, network architecture, and institutional environment) and suggest that optimal SCRM is context dependent—balancing efficiency and resilience.

### **3. Taxonomies of supply-chain risks and mitigation strategies**

A recurring contribution of SCRM reviews is the classification of risk types and a systematic mapping of mitigation strategies.

#### **3.1 Risk taxonomies**

Across reviews, typologies usually include supply-side risks (supplier failure, capacity constraints, quality issues), demand-side risks (forecast error, demand volatility), operational risks (machine breakdown, labour strikes), environmental and catastrophic risks (natural disasters), political/regulatory risks, and security/cyber risks. Manuj & Mentzer and Christopher & Peck provide commonly cited classifications that have informed subsequent empirical instruments and modeling efforts.

#### **3.2 Strategy taxonomies**

Mitigation strategies are often grouped into proactive (preventive) and reactive (response/recovery) measures:

- **Proactive strategies:** supplier diversification/multi-sourcing, supplier development and long-term relational contracts, inventory buffering (safety stock), postponement and product modularity, process re-engineering for agility, investments in IT/visibility and analytics, and financial hedging/insurance.

- **Reactive strategies:** contingency planning and business continuity planning (BCP), emergency sourcing, rapid re-routing of logistics, and crisis management teams.

Reviews stress that many strategies involve trade-offs: redundancy (extra inventory or spare capacity) increases resilience but raises cost and may hurt competitiveness; diversification reduces single-point failure but increases complexity. Tang's review links particular quantitative models (inventory models, stochastic programming, robust optimization) to different strategy classes and highlights the methodological focus on high-frequency/low-impact problems versus the relative scarcity of models addressing low-frequency/high-impact disruptions.

### **4. Quantitative modeling and measurement approaches**

A large strand of literature develops and applies mathematical and simulation models to SCRM. Methods include:

- **Stochastic inventory and safety-stock models** (to evaluate trade-offs between stock holding and stockout risk).

- **Robust optimization and stochastic programming** (to design sourcing and production plans under uncertainty).

- **Network/graph models and contagion simulations** (to identify critical nodes and study shock propagation).

- **Simulation (discrete-event, agent-based)** to assess combined strategy effects and evaluate “what-if” scenarios for disruptions.

- **Multi-criteria decision-making (MCDM) and analytic hierarchy process (AHP)** to prioritize suppliers and mitigation options when multiple dimensions (cost, lead time, risk) matter.

Tang (2006) and later Sodhi & Tang reviews summarize these quantitative approaches and their applicability, but also emphasize that many models assume data availability and computational capacity that may not be realistic for SMEs or fragmented networks. Thus, there is a recognized gap between sophisticated modeling and managerial feasibility, especially in emerging economies.

## **5. Empirical evidence on strategy adoption and effectiveness (international)**

Empirical work—surveys, field studies, and case research—has documented patterns of SCRM adoption and provided mixed evidence on effectiveness.

### **5.1 Survey and cross-sectional evidence**

Large-sample surveys and firm-level studies (often focused on manufacturing and logistics firms in North America, Europe, and East Asia) show that larger firms and those embedded in global value chains are more likely to invest in SCRM capabilities (IT systems, supplier development, contingency planning) and to adopt proactive measures. For example, Wagner & Bode find that firms with better supply-chain visibility and closer supplier relationships show lower vulnerability. Pettit et al. developed instruments (SCRAM) to measure resilience capabilities and linked these to recovery performance.

### **5.2 Case studies and anecdotal lessons**

High-profile disruptions (the 2011 Tōhoku earthquake/tsunami, the 2010 Icelandic volcanic ash, floods in Thailand) generated rich case material showing how single-supplier dependence and geographic clustering can create catastrophic supply interruptions. Sheffi's case analyses illustrate how redundancy, flexible sourcing, and rapid managerial decision-making enabled some firms to recover quickly while others suffered prolonged losses. These cases underscore the importance of both upstream supplier assessment and downstream distribution contingencies.

### **5.3 Measuring resilience and outcomes**

A persistent measurement challenge is operationalizing “resilience.” Pettit et al. proposed measurement dimensions (preparedness, response, recovery) and validated an assessment instrument; however, the literature still lacks universally accepted, empirically validated metrics connecting investments to observed post-disruption performance across contexts. Reviews call for longitudinal and event-driven data to credibly identify causal effects of SCRM investments.

## **6. SCRM in practice: Patterns, trade-offs, and governance**

The literature identifies empirical recurring managerially relevant patterns:

- **Managerial attention and resource constraints matter.** Large MNCs allocate budgets to SCRM and run structured BCPs; smaller firms often rely on informal practices and reactively manage crises. Cost and perceived probability drive many SCRM decisions.
- **Supplier relationships and development** appear as a cost-effective mitigation route: stronger relationships, training, and joint problem-solving often outperform simple market-based switching in crisis contexts. However, close ties can create lock-in and contagion risk if a critical supplier fails.
- **Information and visibility** are critical: the ability to observe upstream disruptions early allows lead time for response, and firms investing in integrated ERP and supplier portals generally have better coordination during crises. Yet visibility into tier-2/tier-3 suppliers remains difficult and is an active research/practice frontier.
- **Portfolio approaches:** combination strategies (e.g., moderate safety stock + dual sourcing + contingency contracts) often dominate single levers in simulation studies, because they balance cost and resilience. Reviews recommend policy-sensitive portfolios tailored to firm size and sector.

## **7. Emerging themes to 2018: resilience, digitalization, and systemic risk**

By the mid-to-late 2010s, three cross-cutting themes strengthened in the literature:

1. **Resilience as strategic objective.** The narrative shifted from risk avoidance to resilience building — designing supply chains to adapt and recover, not merely to prevent every disruption. This gave greater emphasis to flexibility, real options, and adaptive governance.
2. **Digital tools and visibility.** Advances in IT, big data, and analytics were promoted as enablers of early detection and faster response. However, researchers noted digital adoption gaps and cybersecurity/new-risk tradeoffs. Tang and others highlighted that technological solutions must be coupled with process and governance changes to be effective.
3. **Systemic and networked risk.** Scholars increasingly recognized that local mitigation by many firms could generate systemic vulnerabilities (e.g., concentration of suppliers in a low-cost region). Thus policy and industry coordination became a research priority — to manage systemic externalities and infrastructure vulnerabilities.

## **8. Indian SCRM research up to 2018 — what is known**

Compared with the global scholarship, India-focused empirical research on SCRM through 2018 was limited but growing. The Indian evidence reveals context-specific constraints (fragmented supplier bases, infrastructure gaps,

regulatory variability across states, and a prevalence of resource-constrained SMEs) that influence strategy choice and effectiveness.

### **8.1 Descriptive and survey studies**

Several India-based studies (academic and practitioner reports) conducted surveys and case analyses across manufacturing sectors to document the types of risks experienced and common mitigation practices. Udbye's doctoral work (2014) and other empirical explorations document that Indian firms commonly face supplier reliability issues, transport/infrastructure delays, and demand uncertainty — and that larger firms are more likely to employ formal SCRM measures such as ERP systems and contingency planning. Shenoj et al. (2018) and Chand (2017) applied multi-criteria techniques to prioritize risks and select supply-chain configurations in the Indian manufacturing context, illustrating the use of MCDM/AHP methods in managerial decision support for risk-sensitive supplier selection. These studies indicate adoption of quantitative decision tools in Indian firms and highlight sectoral differences in risk prioritization.

### **8.2 Case studies and cluster analyses**

Industry-specific work (e.g., in pharmaceuticals, automotive components, textiles) documents how clustering and supply-chain co-location — a strength for efficiency — also creates geographic concentration risk. Studies on the Indian pharmaceutical sector highlight the importance of regulatory compliance, traceability, and supplier qualification for export competitiveness; these studies identify visibility and supplier development as key drivers of resilience in practice.

### **8.3 Methodological tendencies in Indian studies**

Indian SCRM research up to 2018 largely relied on cross-sectional surveys, case studies, and MCDM methods. There were fewer longitudinal or event-driven studies that could measure causal effects of SCRM investments on recovery outcomes. The limited availability of firm-level disruption event data and the fragmented nature of Indian supplier networks were cited as empirical obstacles. Reviews of the Indian literature up to 2018 called explicitly for mixed-method research combining surveys, in-depth cluster case studies, network mapping, and simulation to create practically relevant guidance for SMEs and policymakers.

## **9. What Indian studies reveal about strategy effectiveness and constraints**

Synthesis of India-focused findings suggests several consistent points:

- **Scaling and resource gaps:** Smaller Indian manufacturers (SMEs) often lack the capital and skilled personnel to adopt advanced IT systems or to hold large safety stocks, leading to greater reliance on relational mechanisms and informal contingency arrangements. Larger firms and multinationals in India more often implement formal BCPs and digital visibility tools.
- **Supplier development as feasible mitigation:** Because alternative suppliers are not always readily available, Indian lead firms often invest in supplier development (quality training, process upgrades). This relational approach is both a mitigation and a competitiveness strategy for export-oriented firms.
- **Infrastructure and state heterogeneity amplify risk:** Poor transport reliability, congested ports, and state-level regulatory variability increase lead-time uncertainty and shape firms' inventory and sourcing choices. Several studies link infrastructure quality to higher safety-stock policies and demand for local buffer inventories.
- **Adoption of decision tools but limited event-based validation:** Indian research demonstrates interest in MCDM, AHP, and simulation tools for supplier selection and network design, but there is limited empirical validation tying these tools to measured recovery outcomes after actual disruptions.

## **III. Conclusion**

The reviewed literature reveals that supply chain risk management in Indian manufacturing remains at an evolving stage. While global theoretical advances emphasize resilience, collaboration, and digital integration, Indian firms predominantly focus on traditional buffer-based measures such as safety stock and supplier diversification. The shift from reactive to proactive risk management is gradual but visible in larger, export-oriented industries. A recurring insight across the literature is that **organizational culture, information visibility, and inter-organizational trust** are as critical as technological tools in mitigating disruptions. The absence of formalized SCRM structures and limited adoption of data-driven analytics hinder resilience. Furthermore, infrastructural bottlenecks and policy unpredictability amplify risk exposure for Indian manufacturers. Theoretical models underscore that **dynamic capabilities**, including learning, sensing, and resource reconfiguration, enhance the firm's ability to manage risk. Indian studies corroborate that managerial commitment, integration of suppliers, and technology adoption substantially influence SCRM effectiveness. Nonetheless, gaps remain in empirical validation of these frameworks in emerging-market contexts. Future research should therefore focus on longitudinal and sector-specific analyses combining quantitative and qualitative data. Policymakers should foster



capacity-building initiatives for SMEs, promote risk-sharing consortia, and integrate digital platforms to enhance supply chain visibility. Strengthening SCRM in India is not only a strategic imperative but also a developmental necessity to achieve sustainable manufacturing under global uncertainty.

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