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Building Supply Chain Resilience: Concepts, Capabilities and Lessons from Recent Disruptions

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ABSTRACT

Recent years have shown how quickly supply chains can be disrupted by pandemics, natural disasters, geopolitical events and transport bottlenecks. This review examines the concept of supply chain resilience — the ability to prepare for, respond to and recover from disruptions — drawing on established literature in logistics and operations management. It distinguishes resilience from efficiency, explains the bullwhip effect as a mechanism through which disruptions are amplified, and identifies the capabilities associated with resilient supply chains: visibility, flexibility, redundancy, collaboration, agility and a supportive risk-management culture. It discusses the trade-offs between resilience and cost and proposes a practical sequence for organisations: map critical supply chains, identify single points of failure, prioritise by impact, build targeted buffers and flexibility, and review regularly. The article concludes that resilience should be designed selectively, focusing on the products and suppliers where disruption would cause the greatest harm.

Keywords: supply chain resilience; risk management; disruption; visibility; redundancy; flexibility; bullwhip effect

1. Introduction

For several decades, supply chain management emphasised efficiency: lean inventories, global sourcing from the lowest-cost locations and concentration on fewer suppliers. These strategies reduced costs, but they also reduced the margin for error. When disruptions occur, efficient supply chains with little slack can fail quickly.

Large-scale disruptions — including the COVID-19 pandemic, extreme weather events and blockages of major shipping routes — have brought resilience to the centre of management attention. This review summarises the concept of supply chain resilience, the capabilities that support it and the practical choices organisations face.

2. The concept of resilience

Christopher and Peck (2004) defined supply chain resilience as the ability of a system to return to its original state or move to a new, more desirable state after being disturbed. Ponomarov and Holcomb (2009) emphasised three phases: readiness before a disruption, response during it, and recovery after it. Sheffi (2005), in his study of how enterprises cope with disruption, highlighted redundancy and flexibility as the two main sources of resilience, and noted that flexibility often provides benefits in normal times as well.

Resilience is not the same as risk avoidance. Some disruptions cannot be prevented; resilience concerns the capacity to absorb and adapt.

3. How disruptions are amplified

Lee, Padmanabhan and Whang (1997) described the "bullwhip effect": the tendency of order variability to increase as one moves upstream from consumers to retailers, distributors, manufacturers and suppliers. Causes include demand forecasts based on orders rather than actual consumption, order batching, price fluctuations and shortage gaming, in which customers over-order when supply is rationed. During disruptions, these mechanisms can turn a modest change in demand into severe shortages and later surpluses.

Analyses of epidemic outbreaks have also shown that the impact on supply chains depends strongly on the timing of facility closures and reopenings and on how disruption spreads across the network (Ivanov, 2020).

4. Capabilities of resilient supply chains

4.1 Visibility

Knowing where materials are, which suppliers depend on which sub-suppliers, and what inventory exists across the network allows earlier detection of problems and faster response. Many organisations know their direct suppliers but not the tiers beyond them.

4.2 Flexibility

Flexibility includes the ability to switch suppliers, move production between sites, change transport modes and adjust product specifications. Standardised components and qualified alternative suppliers increase flexibility.

4.3 Redundancy

Redundancy means holding deliberate reserves: safety stock, spare capacity, or additional suppliers. It increases cost in normal times and must therefore be targeted.

4.4 Collaboration

Sharing information on demand, capacity and risks with suppliers and customers reduces the bullwhip effect and supports coordinated responses.

4.5 Agility

Agility is the speed with which an organisation can sense change and act. Clear decision rights and pre-agreed response plans shorten reaction times.

4.6 Risk-management culture

Resilience depends on people. Organisations that discuss risks openly, test plans through scenarios and learn from incidents respond more effectively than those that treat risk as a compliance exercise.

5. Trade-offs

Each capability has a cost. Safety stock ties up capital; alternative suppliers require qualification and may be more expensive; information systems require investment. The central management

question is therefore not whether to invest in resilience, but where. Not every product and supplier deserves the same protection.

6. A practical sequence

1. **Map critical supply chains,** including key sub-tier suppliers for the most important products.
2. **Identify single points of failure,** such as a sole supplier, a single factory or a single transport route.
3. **Prioritise by impact,** considering revenue, customer commitments, safety and the time needed to recover.
4. **Build targeted resilience:** buffers for critical items, qualified alternative suppliers, flexible contracts and shared information.
5. **Prepare response plans** and test them through scenarios.
6. **Review regularly,** because suppliers, markets and risks change.

7. Implications

For managers, resilience should be included in sourcing decisions alongside price and quality. For small and medium-sized enterprises, simple measures — knowing their critical suppliers, holding modest buffers for key inputs and maintaining relationships with alternative suppliers — can provide substantial protection. For educators, the topic underlines the need to teach supply chain management as risk management as well as cost optimisation.

8. Conclusion

Supply chain resilience is the capacity to prepare for, respond to and recover from disruption. It rests on visibility, flexibility, redundancy, collaboration, agility and culture. Because these capabilities carry costs, resilience should be designed selectively, focusing on the parts of the supply chain where disruption would cause the greatest harm.

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