



Supply Chain Resilience and Risk Management

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Abstract. This study examines supply chain resilience and risk management in manufacturing enterprises, focusing on single-source and regional dependency. Based on case evidence and interviews, it analyses disruptions involving nickel, imported reduction gears, and specialised packaging materials. The findings show that concentrated sourcing can interrupt production, delay delivery, and cause financial losses. Manufacturers can strengthen resilience through backup suppliers, multi-regional procurement, safety stock, real-time monitoring, strategic collaboration, and flexible logistics. Identifying critical supply choke points before disruption is essential for maintaining operational continuity.

Keywords: Supply chain resilience; Risk management; Current Affairs Analysis; Supplier diversification; Manufacturing

1 Introduction

Manufacturing supply chains are increasingly exposed to disruptions caused by geopolitical conflict, public health emergencies, environmental regulation, trade restrictions, and logistics bottlenecks (Gebhardt et al., 2022). Although global sourcing can reduce costs and provide access to specialised materials and technologies, it also creates vulnerabilities when critical inputs depend on one supplier, country, or transport route. Once that source fails, disruption can spread rapidly from procurement to production, delivery, inventory, and customer service. Supply chain resilience has therefore become an essential part of manufacturing risk management (Pettit et al., 2010).

This study examines how single-source and regional dependency affect manufacturing enterprises and how managers can reduce these risks. Drawing on interview evidence and a Grounded Theory-based case analysis, it considers disruptions involving Russian nickel supplies, German reduction gears, and specialised packaging materials. These cases show how a lack of qualified alternatives can turn one failed supply node into a production choke point and create substantial economic losses. The paper also evaluates resilience measures, including backup supplier development, multi-regional procurement, strategic collaboration, safety stock, real-time monitoring, shared production capacity, and flexible emergency logistics. By comparing the causes, responses, and outcomes across the cases, this research explains how manufacturers can identify

critical dependencies, shorten crisis response times, and balance cost efficiency with supply continuity in practice.

2 Theoretical Background

Before selecting the research topic, the group reviewed literature on supply chain resilience, supply risk, and manufacturing performance. Kumar et al. (2018) combined 103 survey questionnaires with six in-depth interviews in the Chinese manufacturing sector and found that supply and manufacturing risk management have important implications for business performance. This evidence supports the need for manufacturers to treat resilience as a strategic capability rather than a short-term emergency response. More recent studies similarly emphasise supplier collaboration, supply chain mapping, risk-based supplier selection, and data analytics as important mechanisms for improving resilience and performance (Bahrami et al., 2022; Gebhardt et al., 2022). These findings provide the theoretical basis for examining how concentrated sourcing and a lack of qualified alternatives can expose manufacturers to severe operational disruption.

From a theoretical perspective, supply chain resilience is not limited to recovery after a disruption. It also includes the ability to anticipate threats, absorb their immediate effects, adapt operating plans, and restore performance within an acceptable period. Pettit et al. (2010) argue that resilience depends on balancing supply chain vulnerabilities with the capabilities available to manage them, while Craighead et al. (2007) emphasise that disruption severity depends on both supply chain design and mitigation capability. These ideas suggest that efficiency and resilience should not be treated as competing objectives. A low-cost sourcing arrangement may create hidden exposure if it removes redundancy, limits visibility, or increases the time required to qualify an alternative supplier.

3 An Empirical Analysis Based on Case Studies

Our analysis identifies this as the most urgent and destructive issue facing factory managers. The Grounded Theory charts reveal a critical vulnerability: whether multinational giants or medium-sized manufacturers, there is a prevalent over-reliance on specific suppliers, geographic regions, or imported equipment without adequate alternatives (Craighead et al., 2007; Tang, 2006).

3.1 Risk Manifestation

The fragility of the supply chain is exposed when geopolitical conflicts, public health events, or policy shifts trigger a failure at a single node, dealing a "fatal blow" to operations (Craighead et al., 2007).

3.2 Empirical Evidence

The interview data provides stark examples of this vulnerability. Taiyuan Iron & Steel Group (TISCO) reported that due to the Russia-Ukraine conflict, a core Russian nickel supplier—accounting for 22% of their procurement—suspended supply for 68 days. This disruption directly affected the production of high-end stainless steel, resulting in an economic loss of approximately 86 million RMB. Similarly, the medium-sized machinery enterprise faced a severe "choke point" when German-imported reduction gears were cut off for three weeks during the Shanghai lockdown. The lack of qualified domestic alternatives forced a production halt, causing a loss of 6 million RMB. Even a mature enterprise like P&G noted potential risks, acknowledging that a specific U.S. supplier provided 15% of a special fragrance, constituting a single-source dependency that required the urgent development of backup suppliers.

3.3 Analysis

This "lack of Plan B" makes supply interruption the "number one threat" perceived by managers, as a single failure can trigger a chain reaction of delayed orders.

The cases further indicate that the severity of a disruption is determined by more than the percentage purchased from one supplier. The technical uniqueness of the input, the time needed to certify a substitute, available inventory, and the speed of managerial decisions are equally important. A relatively small purchasing share can still become a critical bottleneck if the material is essential to the final product. For this reason, managers should evaluate dependencies according to business impact and recovery time rather than procurement value alone. Without this broader assessment, conventional cost and supplier-performance measures may fail to reveal the most dangerous choke points (Craighead et al., 2007; Pettit et al., 2010).

4 Problem solving strategy and deep cause analysis

In this section, we will address the two issues raised in Part 3. We will analyze and explain them separately as follows:

4.1 Supply-Side Crisis: The "Choke Point" Risk under Single-Source Dependency

The first issue is the high reliance on single suppliers for critical materials, which creates a risk of supply disruption and a lack of alternatives. This vulnerability was fully exposed by events like the pandemic and geopolitical conflicts (Gebhardt et al., 2022).

Problem Description. The first company procured many critical components externally, typically relying on just one or two manufacturers. This single-source supply chain meant that any disruption to its sole supplier could bring production to a standstill.

During the pandemic, this dependency triggered severe inventory overstocking, primarily because planned projects either failed to meet deadlines or were delayed by clients. As a result, specialized components prepared for these projects accumulated in warehouses, rendering them unusable.

The second company also faced similar challenges, having historically relied heavily on suppliers from specific regions like Vietnam. When Vietnam imposed a six-month lockdown due to the pandemic, the entire supply chain was disrupted. This forced the company to advance its order placement by a full eight months. Moreover, the increasingly complex international trade environment—encompassing trade frictions, anti-dumping investigations, and carbon emission mechanisms—has created substantial compliance costs and uncertainties. Although they later enhanced supply chain resilience through decentralized procurement, issues like inaccurate demand forecasting and inventory management remain major challenges.

The last remaining daily chemical company faced critical risks centered on packaging materials. Its production of shampoo and shower gel bottles heavily depended on a single core supplier for a specific plastic component. When the supplier was forced to halt production due to environmental compliance issues, the supply chain was immediately disrupted. Despite lacking immediate alternatives, the company responded swiftly by using 3D printing technology to temporarily fill mold gaps and coordinating with other factories to share production capacity, restoring market supply within ten days and preventing shortages. This incident, along with inter-provincial transportation disruptions during the pandemic and shipping route changes caused by the Red Sea crisis, exposed vulnerabilities in the company's supply chain regarding logistics interruptions and cost fluctuations. Post-incident, the company strengthened risk management by establishing a "Supply Chain Control Tower" system for real-time monitoring of key risk indicators, while increasing domestic procurement ratios and safety stock standards. However, the risk of being "strangled" by critical material shortages remains, and the fundamental issue of over-reliance on a single supplier has yet to be fully resolved.

Across the three companies, the deeper causes of vulnerability were also organizational. Long-term cooperation with familiar suppliers encouraged stability, but it reduced the urgency of developing alternatives. Specialised technical requirements, quality certification, tooling investment, and switching costs made replacement slow even when managers understood the risk. In addition, inaccurate demand forecasts amplified the consequences of disruption by creating either excess project-specific inventory or shortages of urgently needed materials. These conditions show that single-source dependency is rarely caused by one procurement decision. It develops gradually through accumulated choices concerning product design, supplier qualification, forecasting, inventory policy, and regional sourcing (Pettit et al., 2010).

Measures, Reasons, and Outcomes. In the face of the above problems, each company has adopted different coping strategies.

The first company adopted a two-pronged strategy. On one hand, they focused on developing backup suppliers as a foundational approach to reduce reliance on single sources. On the other hand, they sought to establish "deep collaboration" with core suppliers, ensuring supply stability through robust strategic partnerships. Recognizing the

risks of overdependence on external sources, they aimed to consolidate relationships with existing partners while exploring alternatives. These measures stabilized their supply chain development, though the interviews lacked concrete quantitative results, suggesting these initiatives were still in progress and their full impact required further observation (Tang, 2006).

The second company's core strategy is multi-regional procurement to achieve risk diversification. Their specific approach involves diversifying procurement across different markets for critical materials. For instance, they source components with annual demand exceeding hundreds of millions from multiple Asian regions including Vietnam and Taiwan. This decision stems from the profound lessons learned during Vietnam's prolonged lockdown during the pandemic, which exposed the vulnerabilities of over-concentration in one location and triggered a chain reaction of demand amplification and inventory buildup. By strategically positioning across different geographical regions, they leverage Europe's rapid response capabilities and Asia's cost advantages while effectively hedging against localized risks like port closures. Ultimately, their supply chain risks have become highly diversified, enabling the company to strike a better balance between cost competitiveness and rapid response capabilities, thereby enhancing overall customer delivery performance (Gebhardt et al., 2022; Tang, 2006).

The daily chemical company implemented a comprehensive strategy. They heavily invested in nurturing "backup suppliers," such as funding two domestic alternative suppliers to address critical bottlenecks in high-precision pump heads. Simultaneously, they signed long-term strategic agreements with core suppliers, committing to prioritize procurement volumes in exchange for guaranteed supply and reserved emergency capacity. Operationally, they established an efficient emergency response mechanism with a clear decision-making logic: first activating safety stock, then engaging backup suppliers, and finally switching logistics channels at any cost. This approach was triggered by a sudden supply disruption caused by environmental restrictions on core suppliers, which exposed their lack of immediate backup solutions. These measures proved highly effective, reducing critical material supply risks from "fatal" to "manageable" and cutting emergency response time from 48 hours to an average of 12 hours. Although logistics costs would spike temporarily during crises like the Red Sea incident, swift decision-making ensured uninterrupted supply, avoided greater losses from production halts and customer attrition, and kept additional costs within acceptable limits. This emphasis on monitoring and adaptive capacity is consistent with evidence linking analytics and resource reconfiguration to supply chain resilience (Bahrami et al., 2022).

A comparison of the responses suggests a practical sequence for resilience planning. First, firms should map critical materials and identify suppliers, regions, and transport routes whose failure would stop production. Second, they should determine minimum safety-stock levels and the time required to activate qualified alternatives. Third, strategic suppliers should be included in joint contingency planning, with emergency capacity and communication responsibilities agreed in advance. Finally, control-tower monitoring should connect external risk signals with clear decision thresholds. This layered approach helps managers avoid both excessive inventory and unprepared dependence. It also turns resilience from an improvised crisis reaction into a repeatable management process that can be reviewed after every disruption (Pettit et al., 2010).

5 Conclusion

This study confirms that single-source dependency is a serious threat to manufacturing supply chains. Disruption at one critical supplier can halt production, delay delivery, increase costs, and cause major financial losses. TISCO's 68-day interruption in Russian nickel supplies affected stainless-steel production and resulted in a loss of approximately 86 million RMB. The machinery enterprise similarly lost 6 million RMB when imported German reduction gears were unavailable for three weeks. These cases demonstrate that an efficient supply chain can remain fragile when essential inputs have no qualified substitute.

The findings also show that resilience depends on combining several measures. Backup suppliers and multi-regional procurement reduce concentration risk. Safety stock, real-time monitoring, shared production capacity, and flexible logistics support faster emergency action. The daily chemical company used 3D printing and capacity sharing to restore supply within ten days, while later improvements reduced response time from 48 hours to 12 hours. Managers should therefore map critical materials, assess geographic and supplier dependencies, qualify alternatives in advance, and establish crisis procedures. Diversification, collaboration, visibility, operational buffers, and rapid decision-making can transform fatal disruptions into manageable risks and strengthen long-term performance.

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