

# From Symptom Treatment to Systemic Diagnosis: The Role of N-Tier Visibility in Supply Chain Resilience

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## Abstract

Global supply chains have evolved into complex, interconnected networks extending beyond direct Tier-1 supplier relationships. Despite this complexity, many organizations continue to assess supply-chain risk primarily through Tier-1 visibility. This can create a false perception of diversification because multiple Tier-1 suppliers may depend on common Tier-2, Tier-3, or deeper-tier sources. This paper proposes a healthcare-inspired conceptual lens for understanding this problem. Just as treating a health symptom without understanding the interdependence of organs and physiological systems may address the manifestation rather than the underlying condition, treating a supply-chain disruption without understanding N-Tier dependencies may resolve an immediate problem while leaving systemic vulnerability intact. Drawing on supply-chain resilience and multi-tier network literature, this paper proposes that N-Tier visibility should enable organizations to identify hidden dependencies, concentration risks, disruption-propagation pathways, and resilience gaps. The paper conceptualizes a progression from **symptom detection to systemic diagnosis**, linking N-Tier visibility with risk concentration, Time-to-Survive (TTS), Time-to-Recover (TTR), and supply-chain resilience.

**Keywords:** N-Tier visibility, supply-chain resilience, supply-chain risk, subtier suppliers, systemic risk, risk concentration, TTR, TTS.

## 1. Introduction

Supply chains are increasingly characterized by global sourcing, multiple supplier tiers, geographical concentration, specialized production capabilities, and interconnected dependencies. Consequently, disruption at one point in the network can affect organizations that may have no direct contractual relationship with the disrupted entity.

Supply-chain resilience literature emphasizes the ability of organizations to prepare for, respond to, and recover from disruptions (Ponomarev & Holcomb, 2009). More recent perspectives extend this concept toward supply-chain viability—the ability of a supply chain to survive and adapt to changing environmental conditions (Ivanov, 2022). However, a fundamental challenge remains: organizations may have visibility of their suppliers without having visibility of the dependencies underlying those suppliers.

This paper proposes a healthcare analogy to explain this challenge. Treating a supply-chain problem without N-Tier visibility is similar to treating a symptom in the human body without understanding the interconnected systems causing it.

The analogy provides a systems-thinking perspective in which a Tier-1 disruption is considered a symptom, while the underlying Tier-2, Tier-3, geographical, material, infrastructure, or other dependencies may represent the root cause.

## 2. The Healthcare Analogy

The human body is an interconnected system. An observable symptom does not necessarily identify the location or cause of the underlying condition. Effective diagnosis therefore requires consideration of the relationships between organs, physiological systems, historical information, and diagnostic indicators. A similar principle applies to supply chains.

Consider a Tier-1 leather supplier that suddenly becomes unable to deliver. The conventional response may be:  
**"Find another Tier-1 supplier."**

However, the actual dependency may extend as follows:

**Tier-1 Supplier → Tier-2 Tannery → Tier-3 Raw-Hide Supplier → Chemical Supplier → Geographic Ecosystem**

Replacing the Tier-1 supplier may therefore resolve the immediate symptom without eliminating the underlying vulnerability.

The parallel can be summarized as:

| Healthcare            | Supply Chain                       |
|-----------------------|------------------------------------|
| Patient               | End-to-end supply network          |
| Organ                 | Supplier/node                      |
| Organ system          | Interconnected supplier network    |
| Symptom               | Supply disruption                  |
| Medical history       | Supplier history/performance       |
| Diagnostic test       | Risk indicators/data               |
| Diagnosis             | Root-cause and dependency analysis |
| Hidden condition      | Hidden N-Tier dependency           |
| Treatment             | Risk mitigation                    |
| Preventive healthcare | Resilience planning                |
| Recovery              | TTR                                |
| Survival capacity     | TTS                                |

The purpose of the analogy is not to suggest that biological and supply-chain systems are identical. Rather, it illustrates the importance of **systemic diagnosis instead of isolated symptom treatment**.

### 3. N-Tier Visibility and Hidden Risk

Traditional supply-chain risk management frequently focuses on direct suppliers. However, empirical research demonstrates that deeper-tier relationships can materially influence focal-firm risk.

Wang et al. (2021), using multi-tier supply-network data, found that a significant proportion of Tier-2 suppliers are shared by Tier-1 suppliers. Their analysis showed that focal-firm risk is associated with the degree to which Tier-2 suppliers are shared, with disruption effects becoming stronger when affected Tier-2 suppliers are more heavily shared.

This finding has an important managerial implication:

**Supplier diversification does not necessarily equal dependency diversification.**

For example, an organization may have four Tier-1 suppliers:

**A + B + C + D**

This appears diversified.

However, N-Tier mapping may reveal:

**A → Common Tier-2**

**B → Common Tier-2**

**C → Common Tier-2**

**D → Common Tier-2**

The organization therefore has four supplier relationships but potentially only **one critical upstream dependency**.

This represents a form of hidden concentration risk.

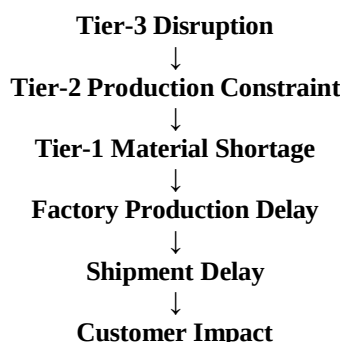
#### 4. From Symptom Detection to Systemic Diagnosis

N-Tier visibility should therefore move beyond simply identifying additional suppliers. Its strategic value lies in understanding **relationships, dependencies and potential risk propagation**.

A proposed conceptual progression is:

**Symptom → Diagnosis → Root Cause → Dependency → Risk Concentration → Propagation → Mitigation → Resilience**

For example:



The point at which the disruption becomes visible—the Tier-1 supplier or factory—is not necessarily the point at which the disruption originated.

Consequently, the critical supply-chain question should evolve from:

**"Which supplier failed?"**

to:

**"What dependency failed, where did it originate, who else shares that dependency, and how far could the disruption propagate?"**

#### 5. Conceptual Framework

This paper proposes that N-Tier visibility contributes to resilience through four principal mechanisms:

**1.1 Dependency Identification:** Mapping Tier-2, Tier-3 and deeper relationships enables organizations to identify dependencies that are invisible within conventional Tier-1 supplier management.

**1.2 Risk Concentration Assessment:** N-Tier mapping enables organizations to determine whether apparently independent suppliers share common upstream sources.

**1.3 Disruption Propagation Analysis:** Network visibility enables organizations to assess how disruption at one node may propagate across multiple tiers and ultimately affect production, delivery, cost and revenue.

**1.4 Resilience Assessment:** The impact of an identified dependency can be evaluated using:

**Time-to-Survive (TTS):** the period for which the organization can continue operating before disruption consequences become unacceptable.

**Time-to-Recover (TTR):** the time required to restore the required level of supply-chain performance.

Conceptually: **If TTS > TTR, the organization has greater capacity to absorb the disruption. If TTS < TTR, a resilience gap exists.**

This perspective is consistent with the broader evolution of supply-chain resilience toward the ability not merely to recover, but to survive and adapt under changing conditions (Simchi-Levi et al., 2014).

#### 6. Research Propositions

Based on the conceptual framework, the following propositions are proposed:

**P1:** Greater N-Tier supply-chain visibility is positively associated with the identification of hidden supply-chain dependencies.

**P2:** Greater N-Tier visibility improves an organization's ability to identify hidden supplier concentration and shared-dependency risks.

**P3:** Greater upstream dependency concentration increases the potential for disruption propagation across the supply network.

**P4:** N-Tier visibility positively contributes to supply-chain resilience through improved risk identification, preparedness, mitigation, and recovery planning.

**P5:** The resilience of a supply network is positively influenced when **TTS exceeds TTR**.

**P6:** Integration of historical supplier-performance data with N-Tier network information improves the organization's ability to identify recurring and systemic vulnerabilities.

## 7. Discussion

The central contribution of this conceptual framework is the distinction between **visibility and understanding**. An organization may possess extensive Tier-1 supplier data and still have limited understanding of its actual supply-chain risk.

The healthcare analogy highlights this distinction. Knowing which organ is producing a symptom is not equivalent to understanding the underlying condition. Similarly, knowing which supplier has failed does not necessarily identify the root cause of a supply-chain disruption.

This leads to three important shifts in supply-chain thinking:

**From Supplier Management → Network Management**

**From Tier-1 Visibility → N-Tier Visibility**

**From Symptom Treatment → Systemic Diagnosis**

The framework also challenges the assumption that adding suppliers automatically reduces risk. If alternative suppliers share the same upstream dependencies, geographical exposure, or critical processing source, the apparent diversification may be misleading.

The strategic objective should therefore not simply be to increase the number of suppliers, but to increase the diversity and independence of critical dependencies.

## 8. Conclusion

Supply chains should be understood as interconnected systems rather than collections of independent Tier-1 suppliers. A disruption visible at Tier-1 may represent only the downstream symptom of a deeper vulnerability within the N-Tier network.

The healthcare analogy provides a useful conceptual lens for this problem. Just as effective diagnosis requires understanding the interconnected functioning of a biological system, effective supply-chain risk management requires understanding the dependencies connecting suppliers, sub-suppliers, materials, processes and geographical ecosystems.

Accordingly:

**N-Tier visibility should not be viewed simply as seeing deeper into the supply chain; it should be viewed as developing the ability to diagnose how risk originates, concentrates and propagates through the supply network.**

The ultimate objective is therefore:

**Visibility → Understanding → Diagnosis → Prediction → Mitigation → Resilience**

This conceptual framework provides a basis for future empirical research examining whether deeper supply-chain visibility, combined with dependency concentration analysis and TTS/TTR measurement, can significantly improve supply-chain resilience.

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