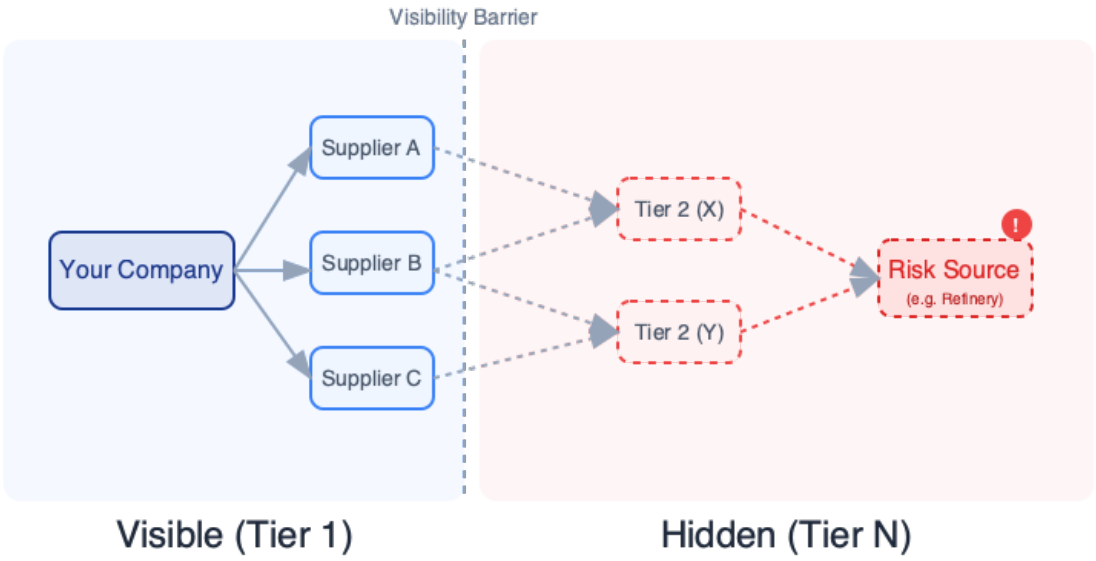
Supply Chain Risk Intelligence for Manufacturing: Achieve N-Tier Visibility with Snowflake

Uncover hidden supplier dependencies and concentration risks before they disrupt your production.

The Problem in Context

Procurement and supply chain teams believe they have diversified sourcing because their ERP shows multiple Tier-1 suppliers across different countries. But that data is incomplete—visibility ends at the first tier.

- **Tier-N blindness costs time and money.** When a disruption occurs at Tier-3, you're blindsided weeks later by sudden shortages, leaving no time to qualify alternatives.
- **Single points of failure hide in plain sight.** Three Tier-1 vendors across three countries may unknowingly source raw materials from the same refinery in a geologically unstable region.
- **Reactive firefighting replaces strategic planning.** Without predictive risk signals, procurement teams spend time managing crises instead of building resilient supply networks.
- **Compliance and audit gaps create exposure.** Regulations like UFLPA require traceability beyond Tier-1, but current systems cannot provide that visibility.



Tier-N Visibility Gap

Traditional ERP visibility ends at Tier-1. Risks fester unseen in deeper layers of the supply network.

What We'll Achieve

This solution transforms supply chain management from reactive response to proactive resilience.

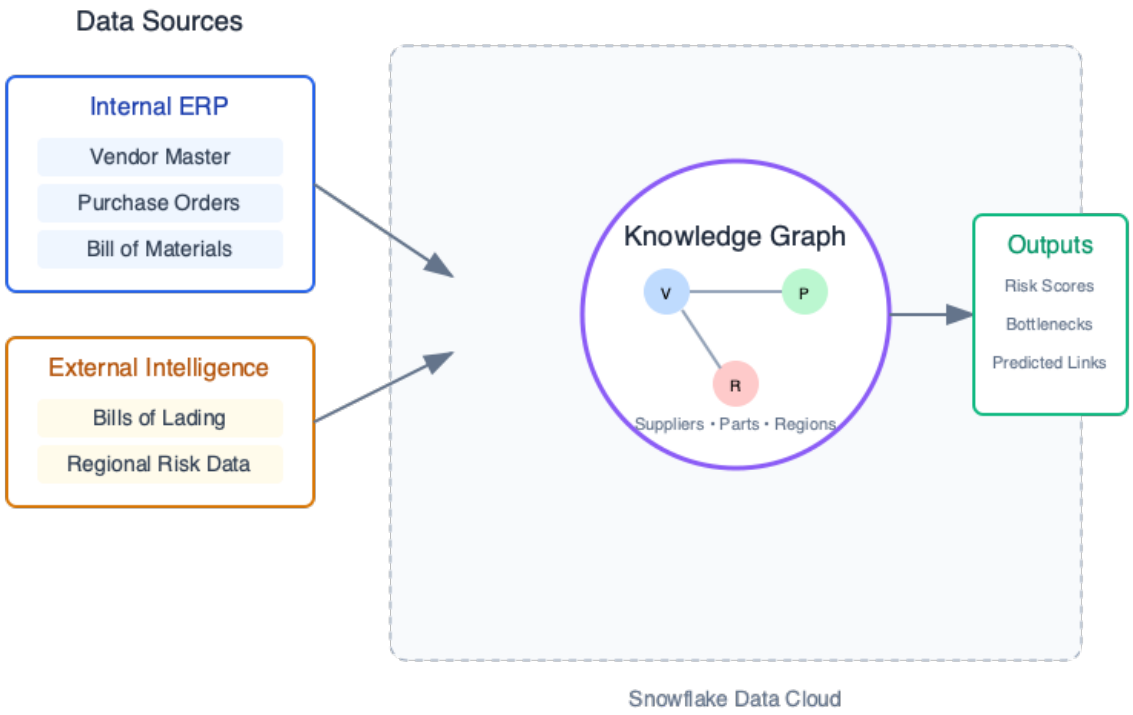
- **Predictive risk scoring.** Alerts for latent risks before they manifest—"Part X has a 75% risk score because its estimated Tier-2 source is in a sanction zone."
- **Automatic concentration discovery.** Identify hidden bottlenecks where multiple Tier-1 suppliers converge on the same Tier-2+ source.
- **Proactive supplier qualification.** Find and qualify backup suppliers months before a crisis, not during one.
- **Faster time to insight.** Reduce supply chain due diligence from weeks of manual research to minutes of AI-powered analysis.

Why Snowflake

- **Unified data foundation.** Internal ERP data and external trade intelligence join seamlessly in a governed platform—no data movement, no pipeline complexity.
- **Performance that scales.** GPU-enabled notebooks train graph neural networks on millions of trade records without infrastructure friction.
- **Collaboration without compromise.** Share risk insights with sourcing partners and internal teams while maintaining data governance and access controls.
- **Built-in AI/ML and apps.** From PyTorch Geometric models to interactive Streamlit dashboards, build and deploy intelligence closer to where decisions happen.

The Data (At a Glance)

The solution fuses two data streams into a knowledge graph that reveals what your ERP cannot see.



Data Architecture

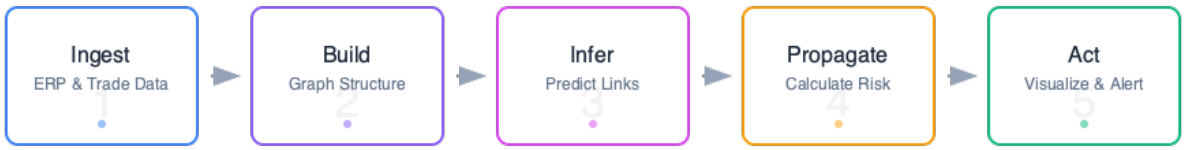
Internal ERP data forms the backbone; external trade intelligence fills in the hidden Tier-2+ relationships.

- **Domains.** Vendors (Tier-1 suppliers), Materials (parts and BOMs), Regions (geographic risk factors), Trade Data (bills of lading linking shippers to consignees).
- **Freshness.** Batch ingestion for ERP data; periodic refresh for trade intelligence. Risk scores update when the GNN notebook executes.
- **Trust.** All data stays within Snowflake's governance boundary. Role-based access controls protect sensitive supplier financials and trade patterns.

Data Source	Type	Purpose
Vendor Master (ERP)	Internal	Known Tier-1 supplier nodes
Purchase Orders (ERP)	Internal	Supplier-to-material transaction edges
Bill of Materials (ERP)	Internal	Product assembly hierarchy

Trade Data (External)	Enrichment	Hidden Tier-2+ relationship inference
Regional Risk (External)	Enrichment	Geopolitical and disaster risk factors

How It Comes Together



Solution Flow

From raw data to actionable risk intelligence in five steps.

1. **Ingest.** Load ERP exports (vendors, materials, purchase orders, BOMs) and external trade data into Snowflake tables. [→ SQL Setup Scripts]

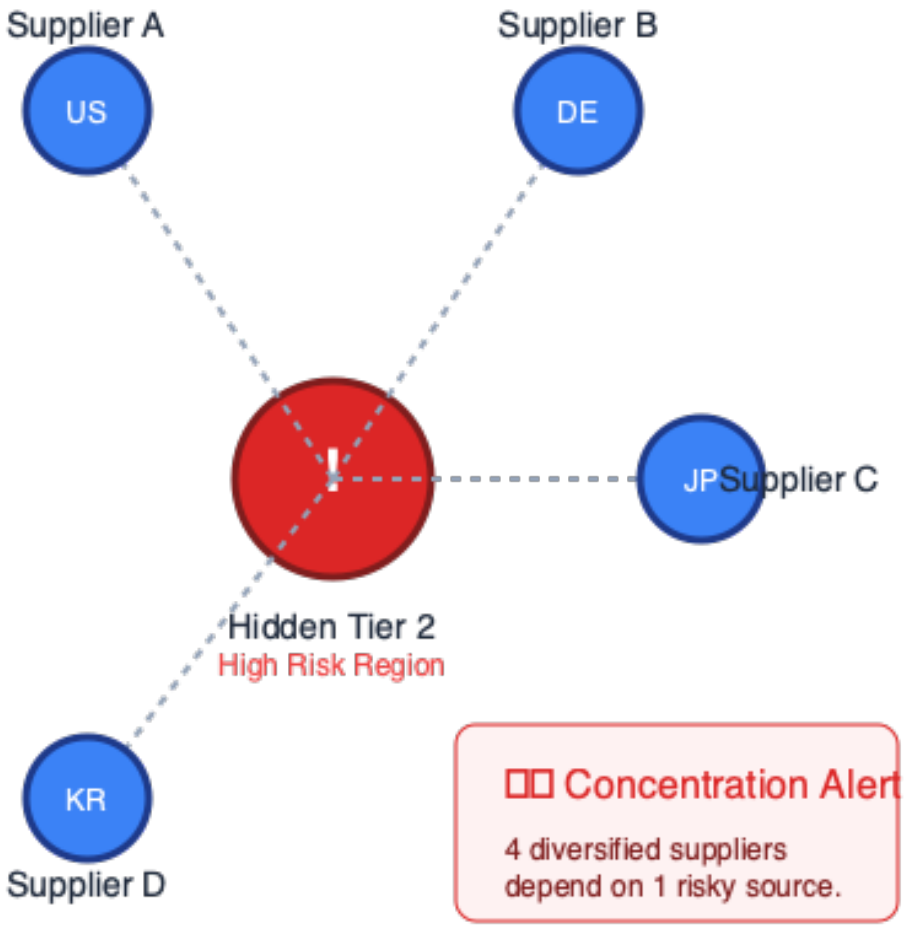
2. **Build the Graph.** Construct a heterogeneous knowledge graph with suppliers, parts, and regions as nodes; transactions and trade flows as edges. [→ GNN Notebook]

3. **Infer Hidden Links.** Train a GraphSAGE model on trade patterns to predict likely Tier-2+ supplier relationships with probability scores. [→ GNN Notebook]

4. **Propagate Risk.** Calculate risk scores that flow through the network—a shock at Tier-3 propagates to impact Tier-1 and final products. [→ GNN Notebook]

5. **Visualize and Act.** Explore the supply network graph, analyze concentration points, and prioritize mitigation actions in an interactive dashboard. [→ Streamlit App]

The Discovery Moment



Concentration Risk Visualization

The "aha" moment: Three seemingly independent Tier-1 suppliers all depend on the same hidden Tier-2 refinery.

Traditional analytics show a diversified supply base. Graph intelligence reveals the convergence.

Before: "We're safe—we source from three different vendors in three countries."

After: "All three vendors rely on one Tier-2 supplier in a high-risk region. We need to qualify alternatives now."

Dashboard Experience

The Streamlit application guides users from executive summary to detailed analysis.

Home — Executive Overview

Key metrics at a glance: nodes analyzed, critical risks identified, bottlenecks discovered, and hidden links inferred.

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Home Dashboard

Supply Network — Interactive Graph

Explore the multi-tier supply network. Filter by node type, zoom into relationships, and trace dependency paths.

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Supply Network Graph

Tier-2 Analysis — Concentration Deep Dive

Examine predicted Tier-2+ links, probability scores, and the suppliers most affected by hidden dependencies.

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Tier-2 Analysis

Risk Mitigation — Prioritized Actions

Action items ranked by impact and probability. AI-assisted analysis provides context for deeper investigation.

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Risk Mitigation

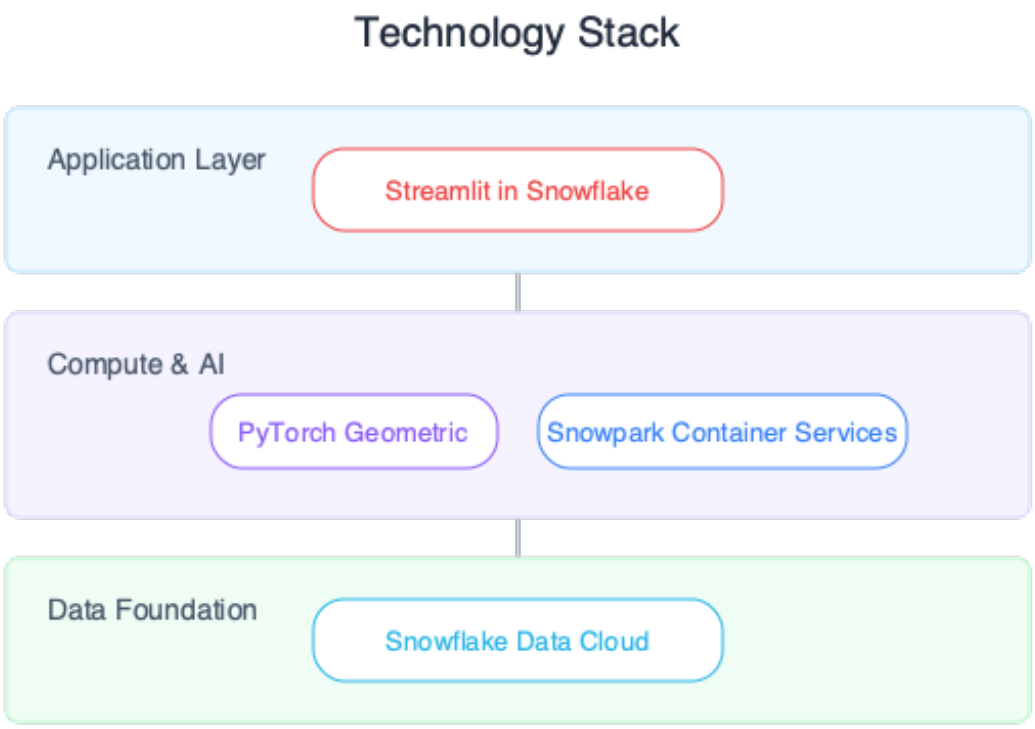
Personas and Value

Persona	Key Need	How This Solution Helps
VP of Procurement	Reduce supplier-driven production disruptions	See concentration risks before they cause shortages; make proactive qualification investments
Supply Chain Manager	Faster risk assessment for critical materials	Propagated risk scores highlight which parts need attention—no manual tracing required
Supplier Quality Engineer	Identify high-risk suppliers for audit	Filter by risk category; prioritize reviews based on network position, not just financials
Data Scientist	Build and iterate on risk models	PyTorch Geometric runs in Snowflake Notebooks with GPU; experiment close to governed data

Technology Foundation

Component	Role

Snowflake Tables	Store ERP data, trade intelligence, and model outputs
Snowflake Notebooks (SPCS)	Execute GNN training with GPU acceleration
PyTorch Geometric	GraphSAGE model for link prediction and risk propagation
Streamlit in Snowflake	Interactive dashboard for exploration and action planning
Snowflake CLI	Orchestrate deployment, execution, and cleanup



Technology Stack

Call to Action

Primary: Run the Demo in Your Account

1. Clone the repository and deploy to your Snowflake account:

`bash

./deploy.sh -c your_connection

`

2. Execute the GNN notebook to generate risk scores:

`bash

./run.sh main

`

3. Open the Streamlit dashboard:

`bash

./run.sh streamlit

`

Secondary: Explore with Your Data

- Review the data architecture and map to your ERP schema
- Identify trade data sources for Tier-2+ enrichment (Panjiva, ImportGenius, UN Comtrade)
- Schedule a working session to design a proof-of-concept with your critical materials

Image Index

The following images should be added to the `solution_presentation/images/` directory:

Filename	Description

`tier_visibility_gap.svg`	Diagram showing visibility ending at Tier-1 with hidden Tier-2/3 suppliers
`data_architecture.svg`	Data flow from ERP + Trade sources to Knowledge Graph
`solution_flow.svg`	5-step pipeline: Ingest → Build → Infer → Propagate → Visualize
`concentration_alert.svg`	Radial graph showing multiple Tier-1 suppliers connected to one Tier-2 bottleneck
`dashboard_home.png`	Screenshot of the Streamlit Home page with key metrics
`dashboard_network.png`	Screenshot of the interactive Supply Network visualization
`dashboard_tier2.png`	Screenshot of the Tier-2 Analysis page
`dashboard_mitigation.png`	Screenshot of the Risk Mitigation prioritization view
`technology_stack.svg`	Visual of the Snowflake + PyG + Streamlit stack

Built with ❄■ Snowflake | ■ PyTorch Geometric | ■ Streamlit