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Graph Technology + Agentic AI

The Future of Root Cause Analysis in Health & Life Sciences Supply Chains

The global health and life sciences (HLS) industry has been buffeted by supply chain disruptions for several years. One effective way for supply chain leaders to bring greater clarity and control to their business is by improving root cause analysis (RCA) with graph technology powered by agentic artificial intelligence (AI). In just a few weeks, Tredence's team can deploy a solution to bring RCA insights into near real-time, enabling cross functional teams to align on decision-making, accelerate their response, and improve business outcomes.

Why RCA is so difficult at HLS companies today

HLS companies operate complex supply chains that span worldwide operations and diverse business functions. They often source active product ingredients from Asia, manufacture in Europe, unpack and repack in the US, and distribute globally. Different supply chain functions such as demand forecasting, planning, manufacturing, quality assurance and distribution use multiple datasets and planning solutions to manage end-to-end supply chain operations. However, they often operate in silos, limiting collaboration and cross-functional insight.

For example, when a product goes out of stock (OOS) at a distribution center, supply chain teams might initially assume they have made a demand forecasting error. However, when team members conduct a deeper root cause analysis (RCA) they often discover multiple contributing factors — such as a delay in raw material shipment from the supplier, a temporary production line slowdown due to maintenance, and a quality hold on finished goods pending inspection. At one HLS company, these issues combined to create a seven-day gap in product availability, resulting in OOS rates rising by 15% in a single region. Without connected insights, these factors are often diagnosed in isolation, delaying resolution.

The HLS industry **loses $1.2T** annually due to inefficient supply chain processes & waste

85% Of pharmaceutical companies report supply chain disruptions impacting drug availability. In addition, around **30%** of all drugs are lost or damaged during transportation due to inefficient supply chain processes.

Supply Chain in the Pharma Industry Statistics, report, Gitnux, 2025, https://gitnux.org/supply-chain-in-the-pharma-industry-statistics/

Many companies utilize traditional methods, such as relational database management system (RDBMS) software, Structured Query Language (SQL), and API integration, to connect and query data sets. Insights are then surfaced on multiple static dashboards & root causes determined by reconciling with multiple dashboards. Companies have adopted this cumbersome approach because there are currently off-the-shelf software solutions that can perform end-to-end RCA.

Traditional RCA methods often delay actionable insights by five to seven days, prolonging operational disruptions. During this window, organizations may continue to experience issues such as stockouts, production downtime, quality deviations, and shipment delays. These problems directly impact key performance indicators (KPIs) such as out-of-stock (OOS) rates, days of inventory outstanding (DIO), and obsolete stock. Other impacted service-level indicators include fill rate, right-first-time (RFT) quality, batch release cycle time, and regulatory compliance rates. Without timely RCA, the underlying issues persist, increasing the risk of product recalls, audit findings, brand erosion, and financial losses.

A faster, smarter way to diagnose root causes: **Graph technology & Agentic AI**

HLS companies can modernize their RCA capabilities in as little as six to eight weeks by adopting graph technology and agent-based AI. These technologies work together to map complex supply chain and quality processes, trace issues end-to-end, and uncover root causes in near real time. With this level of visibility, cross-functional teams—across supply chain, quality, manufacturing, and compliance—can rapidly identify and resolve issues before they escalate. The result is measurable improvement across a range of KPIs, including OOS rates, batch release cycle times, right-first-time quality, fill rates, and regulatory performance. Faster RCA not only reduces disruption—it also strengthens resilience, protects revenue, and ensures continuity of supply for patients and providers.

Graph technology uses structures comprising nodes, also referred to as entities, and edges, also known as relationships, to store and analyze data. Graph databases, such as Neo4j and TigerGraph, enable users to query and visualize relationships to identify new patterns. Users can then trace back inferences and anomalies through nodes and relationships to evaluate interdependencies and their impacts.

An agentic AI framework provides context-aware agents that break down problems into tasks, apply reasoning to solve them, and present the findings in a digestible format.

Types of Agents Include

A Guardrail Agent

Evaluates a user's question, confirms that it is answerable based on the available ontology and data coverage, and delegates tasks to specialized subagents.

Planning Agents

Translate the user's natural language question into efficient cypher query patterns to extract the most relevant data. The second agent uses the data to traverse the knowledge graph, tracing multi-hop relationships across materials, suppliers, inventory states, production, and quality nodes.

Domain-specific Agents

Inventory management, production, and quality agents work with other sub-agents to solve RCA issues to accomplish their unique goals, such as maintaining sufficient inventory on-hand, optimizing fill rates, ensuring efficient production operations, and meeting quality standards.

Summarizing Agent

Synthesizes findings into business-ready summaries with diagnostics, trends, and root causes.

From weeks to real-time leveraging Knowledge Graphs & Agentic AI

Traditional methods used

Relational databases, static dashboards, statistical regression, and decision trees.

1 week

The typical time it takes to identify root causes, due to the need to analyze diverse data sets, explore relationships between entities, develop insights, coordinate across functions, and overcome the limitations of traditional technology

VS

Updated approach

Using graph technology and an agentic AI framework to empower users to rapidly and intuitively discover root causes and prompt remediation.

Near real-time

New time to insight

How graph technology with an agentic framework works

- Establishes entities and their relationships into a comprehensive ontology and knowledge graph.
- Abstracts complexity using LLMs and makes it easier to understand process flows and issues.
- Provides orchestration with a guardrail agent that evaluates questions; breaks them down into tasks; and assigns them to sub-agents that navigate the knowledge graph, recommend process improvements, and summarize findings.
- Makes root causes explainable and traceable.

Key graph features & how they help with RCA

By connecting structured and unstructured information into a single, queryable network, knowledge graphs enable contextual understanding, pattern recognition, and traceability across the value chain. The following features make knowledge graphs uniquely suited for improving RCA speed, precision, and cross-functional collaboration in HLS environments.

01 **Entity relationship mapping**
models the entire supply chain from SKUs and suppliers to plants and warehouses, making it easier to trace issues end to end.

02 **Multi-hop traversal**
connects the dots across multiple steps, such as a supplier delay triggering a production lag that causes a stockout.

03 **Real-time querying**
lets users instantly explore live data and trace issues back to their source without delays or manual data stitching.

04 **Schema flexibility**
allows the model to adapt quickly to changes in products, suppliers, or business processes without requiring rebuilds.

05 **Visual graph exploration**
helps teams see how supply chain elements are linked, making it easier to spot bottlenecks and breakdowns at a glance.

06 **Context-aware reasoning**
is built in, so AI can follow relationships and explain why something happened unlike relational systems that need complex joins.

07 **Impact propagation analysis**
shows how a single issue (like a delayed batch) ripples across the supply chain, affecting downstream metrics like fill rate or service levels.

08 **Historical pattern detection**
uncovers recurring issues by spotting repeated relationships — like certain suppliers or sites often linked to disruptions.

Target Outcomes

Here's what can be achieved by applying graph technology and agentic AI to RCA of inventory issues:

80%

Faster RCA cycle time, reducing diagnostic efforts from days to hours.

10–20%

Reduction in days inventory outstanding (DIO), enabling leaner & more responsive inventory holding.

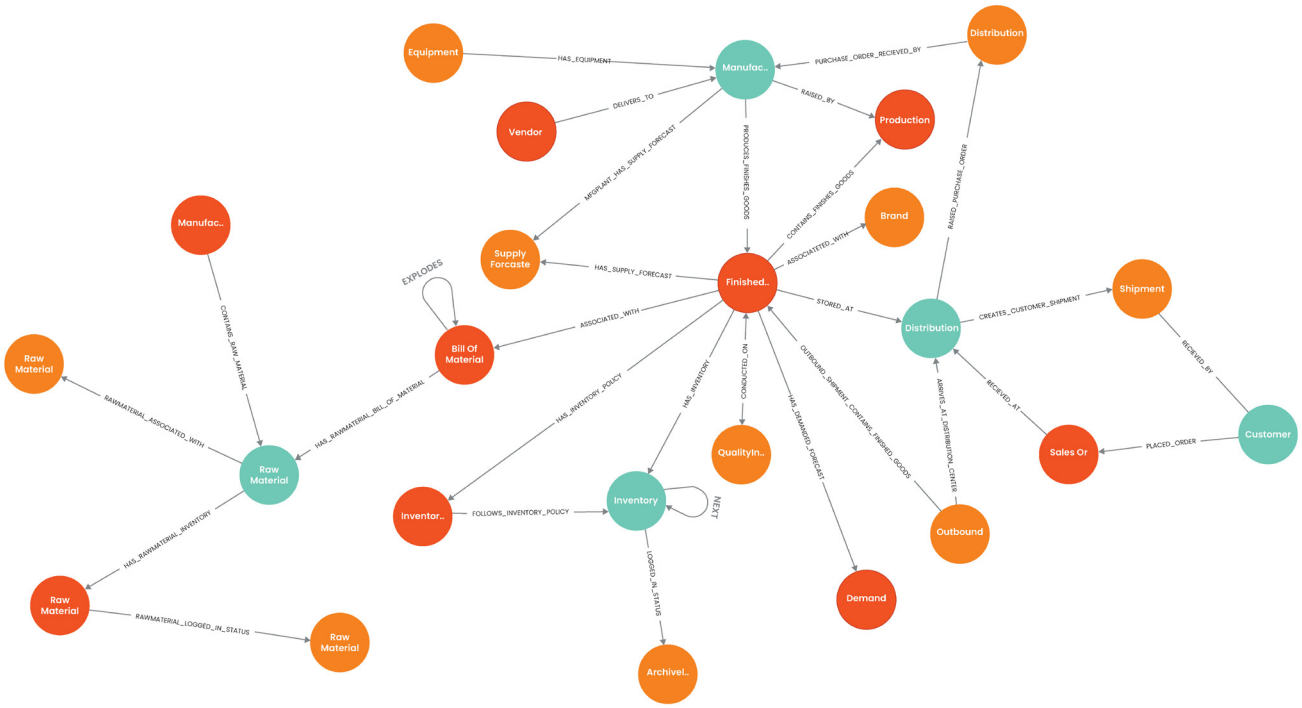
5–10%

Reduction in stock-outs and improved inventory accuracy by resolving supply bottlenecks, data mismatches, and reconciliation issues faster.

10–20%

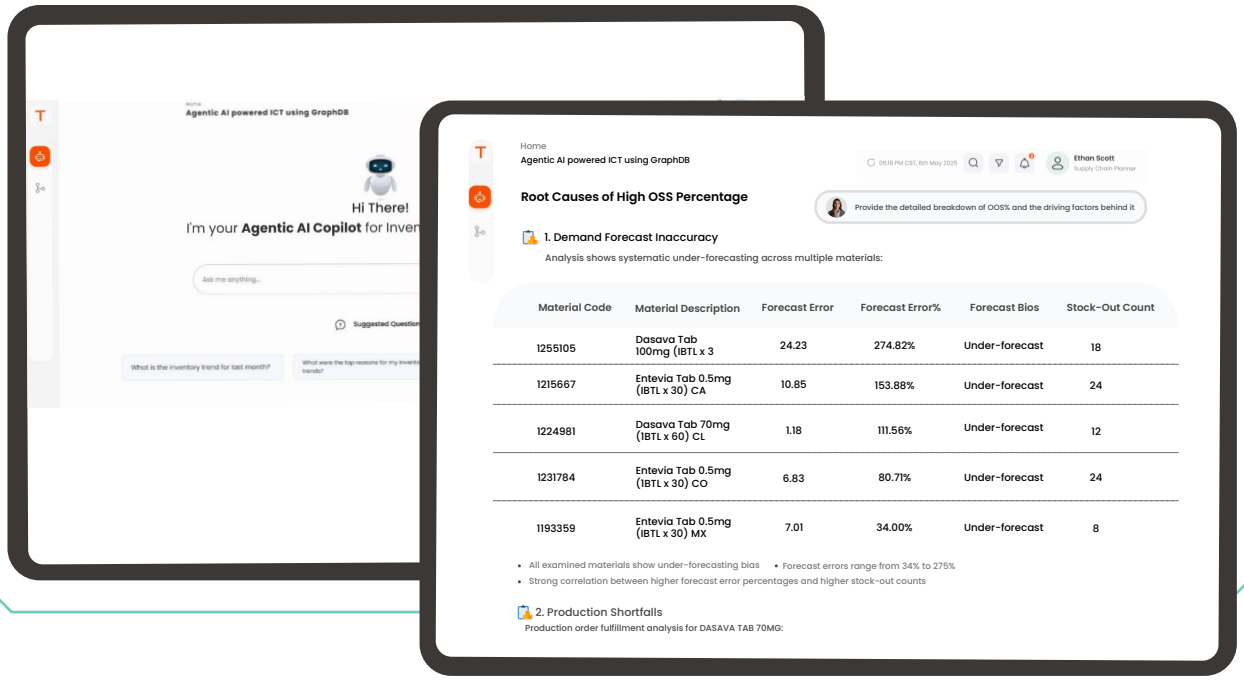
Faster resolution of reorder point breaches, by detecting missed replenishment signals and lead-time variability.

Graph technology enables users to speed RCA & issue resolution



With the ability to visualize relationships and complex interdependencies, it's easier for cross-functional users to identify root causes and develop mitigation strategies.

Graph-powered insights with Agentic AI Copilot for Inventory Control Tower RCA



Benefits of using graph technology with Agentic AI for HLS RCA

By transforming RCA with graph technology and agentic AI, HLS companies can:

01

Gain a holistic view of supply chain processes

Exploring relationships between entities, interdependencies, and business impacts; and identifying hidden connections and patterns that might be missed using traditional analysis methods.

02

Automate root cause identification

Using context-aware, reasoning agents to analyze large data sets in real-time to identify anomalies, patterns, and contributing factors to incidents; ask follow-up questions; and execute tasks, accelerating RCA processes and time to remediation.

03

Improve explainability

Leveraging the graph structure, with visual and semantic (or meaning-rich) relationships, and summarized, persona-based insights, to enable users to understand root causes in context and align around the right path forward.

04

Encourage proactive problem solving

Empowering decision makers to use alerts, natural language queries, and knowledge graphs to identify issues before they cascade into major incidents. By doing so, teams can improve product availability and quality.

05

Improve operational efficiency

Automating RCA processes and incident management with agentic AI, so that teams can focus on setting strategy, progressively improving supply chain processes, and enhancing outcomes.

06

Enhance outcomes

Proactively identifying and mitigating problems with graph technology and RCA enables supply chain teams to avoid common issues such as product out-of-stocks, expiration of unsold batches, cold chain breaches, and more.

07

Dynamically learn

Agentic AI systems learn from new data and past incidents, continually updating their approach and improving the effectiveness of future interventions.

08

Scale to complex networks

Graph technology and agentic AI can easily be scaled across diverse scenarios, large data sets, partners, patient populations, and more, making it ideal for RCA in a variety of HLS environments, such as manufacturing, clinical trials, and US Food and Drug Administration submissions.

Case study

Enabling end-to-end inventory RCA for an HLS supply chain with GenAI and knowledge graphs.

Challenge

A global HLS company sought to implement a centralized RCA engine to solve business challenges, including:

- Siloed visibility across suppliers, manufacturing, quality assurance, and distribution
- Delayed responses to excess products or stockouts
- Difficulties tracking inventory issues across nodes

Requirements

The company sought to create unified visibility and implement a root cause diagnostics model that would provide actionable insights to operations and planning teams. They would then be able to use natural language queries to explore problems, summaries to evaluate root causes, and alert-driven workflows to manage root cause remediation. Below are KPIs for which the RCA were performed.

- Days Inventory Outstanding (DIO)
- Excess or Obsolete Inventory
- Stockout Frequency & Duration
- Fill Rate – %

Solution approach

Defining an inventory ontology

Capturing entities & relationships across stock keeping units (SKUs), suppliers, plants, quality assurance, & distribution.

Implementing a knowledge graph

Loading and linking multi-source inventory data.

Aligning on the RCA & Hypothesis tree

This step involves formalizing the root cause analysis with a structured hypothesis tree to guide the investigation.

Deploying a generative AI-powered RCA agent

Traversing the knowledge graph and explaining root causes using large language models (LLMs).

Building a conversational user interface

Enabling users to ask questions in natural language and triggering RCA flows.

Enabling event driven alerting

Notifying users of metric anomalies, such as OOS or quality issues.

Results

- End-to-end visibility of key inventory drivers across the supply chain
- Fast, explainable RCA for strategic decision-makers
- Improved alignment and decision-making across key functions
- 80%: Faster RCA of inventory anomalies

Get results in weeks

07 Steps to implementing an RCA framework & transforming processes

Supply chain leaders can collaborate with Tredence and utilize this roadmap to gain visibility into RCA processes, manage issues in near real-time, and improve business outcomes.

01 Determine Scope

Collaborate with Tredence to review RCA challenges and business areas that can be improved with graph technology and prioritize areas for a proof of concept, which will be executed in six to eight weeks. Identify key performance indicators (KPIs) for measuring RCA improvements.

02 Data Discovery & Integration

Identify data entities and ingest data from enterprise resource planning (ERP), supply chain management (SCM), and other systems to create a complete picture of supply chain performance. This can be achieved faster by tapping into the Tredence SCM Data Foundation Accelerator's ready-made assets.

03 Define Graph Ontology

Build a graph model with node relationships to solve critical supply chain problems your organization is facing. Define Graph Ontology and RCA Scope – Design the graph model with entities and relationships tailored to address the client's most critical supply chain problems. Identify priority RCA scenarios for these problem areas, guided by the Tredence SCM RCA Hypothesis Library, to ensure the ontology supports automated root cause analysis by the agentic AI solution.

04 Implement The Solution

Deploy the knowledge graph and agentic AI system in your environment, connecting it to ERP and SCM systems for continuous data ingestion and activate agents. The solution can also be connected to a supply chain command center, but this is not required.

05 Connect the agentic AI system

Connect the deployed RCA system to user-facing channels—such as supply chain command centers, dashboards, or conversational interfaces—so stakeholders can run industry-specific queries, trigger processes, and receive real-time insights.

06 Create persona based insights

Leverage the summarizing agent to generate daily RCA summaries with key alert metrics for executives. Empower operators with deep-dive insights into SKUs, batches, and production details.

07 Scale the solution

Make any refinements required and then scale the solution within two to four months to provide all cross-functional contributors with the ability to contribute to RCA and issue resolution.

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Ready to learn more?

Develop modern RCA processes with Tredence

You want to grow your HLS business, revenues, and profitability by minimizing supply chain disruptions and protecting product flow.

Implement graph technology and agentic AI with Tredence to gain a holistic understanding of supply chain processes, explore relationships and root causes, and swiftly implement mitigation strategies that protect your business.

Contact us to schedule a complimentary 60-minute discovery call with a Tredence expert to explore how you can modernize your RCA processes this year.

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