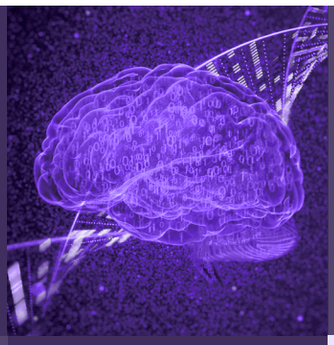
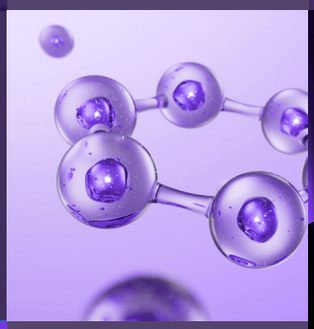




Confederation of Indian Industry

# Agentic AI-enabled Market Intelligence across Supply Chain & Logistics

## A Specialty Chemicals Perspective

July 2026

# Preface

Specialty chemicals companies compete on performance, reliability, and trust. Their products sit inside customer formulations, processes, and devices. This creates durable relationships and switching costs, but it also raises the cost of errors. A misinterpreted regulation can trigger customer escalations. A delayed response to a substance restriction can strand inventory. A missed feedstock shock can compress margins with consequences across an entire contract cycle.[21,22,6]

In this context, market intelligence in specialty chemicals extends far beyond conventional market monitoring. It is the discipline of detecting, interpreting and acting on external signals such as regulatory developments, supply chain disruptions, competitor moves, and demand shifts, then translating them into implications of chemical feasibility, quality and qualification constraints, and operational risk. Teams must interpret signals through questions such as: Can the product be manufactured within specified impurity limits? Does a regulatory restriction apply to the substance class or only to a specific use? Which supply corridors become vulnerable when production is concentrated in a single region?[3,18,20]

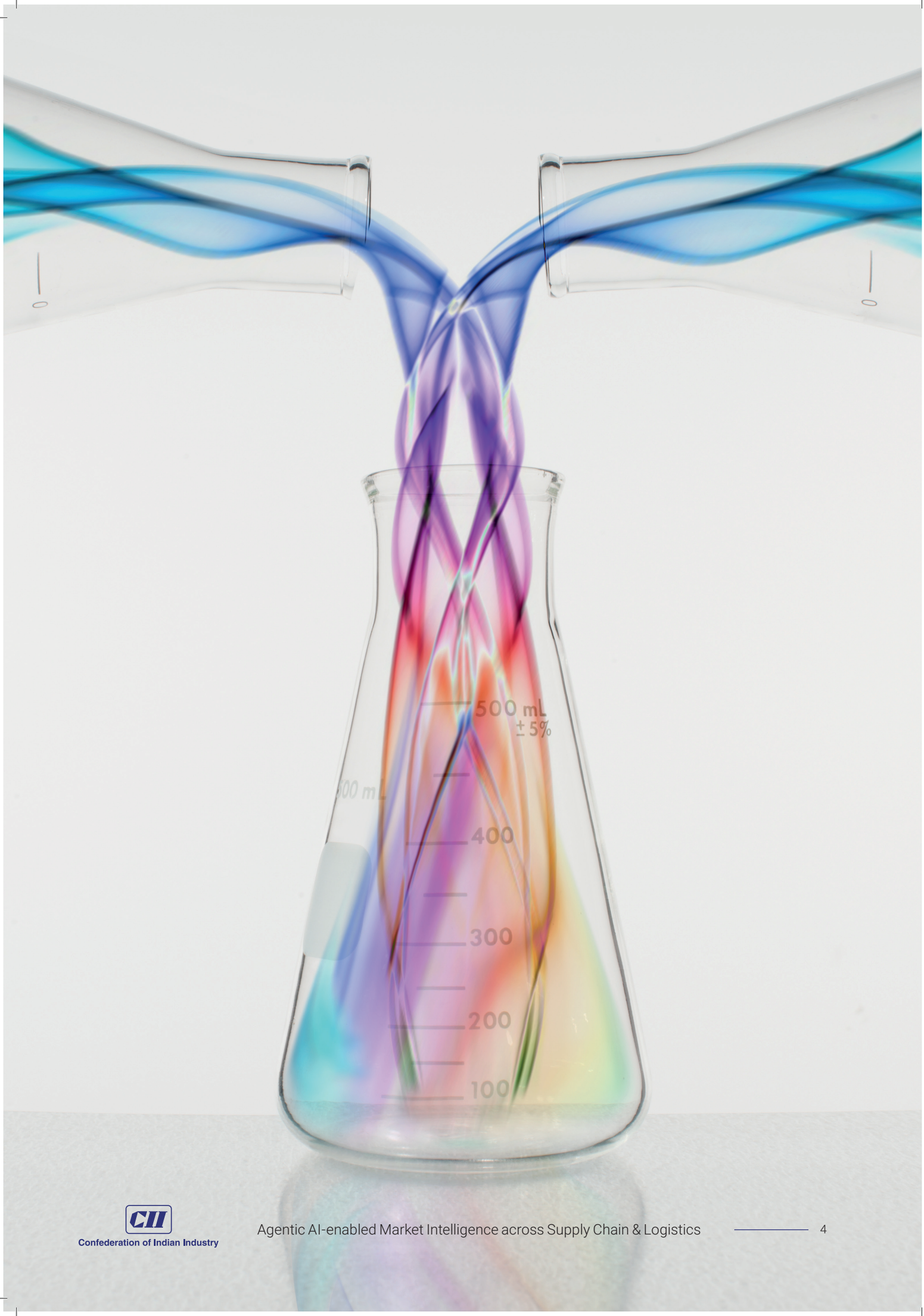
This updated edition also considers LNG as an adjacent-industry illustration of the same market-intelligence challenge. The 2026 supply disruption demonstrated how geopolitical concentration, physical infrastructure, inventory depth, and demand prioritization can interact rapidly during a market shock. While the operating constraints differ from specialty chemicals, the underlying MI principle is similar: external signals create decision value only when they are translated into implications for supply continuity, inventory, procurement, network constraints, and allocation.

India's specialty chemicals sector sits at an important inflection point. Domestic demand continues to broaden across agriculture, pharmaceuticals, consumer goods, construction, polymers, and electronics, while global supply chains are being rebalanced. Public analyses increasingly highlight resilience, sustainability, and digitalization as strategic imperatives for the chemicals value chain. These forces increase the opportunity set, but they also increase the complexity of sensing and acting on signals early.[1,4,7]

This industry context also resonates strongly with the **Logistics Tomorrow – Move Nation** theme. In specialty chemicals, the logistics of tomorrow will be shaped by digital ecosystems, resilient supply networks, and emissions-compliant operations that support both India's growth ambitions and global competitiveness. It will also require new business models grounded in collaboration across the value chain to expand capacity, improve responsiveness, and strengthen long-term competitiveness.

This report is a guide to building agentic models for market intelligence in the specialty chemicals sector. Agentic refers to AI systems that can plan multi-step work, retrieve and synthesize evidence, use analytical tools, maintain task context, and produce decision-ready outputs with confidence cues. The report is written for two audiences. Industry readers will find a sector lens and practical framing of the market intelligence problem. Technical teams will find a structured methodology, design principles, and evaluation and governance guidance.[8,13,9]

Charts are provided in a companion exhibit workbook (Exhibits 1–6). The report references exhibits by number so they can be reused directly in presentations. Tables are included within the report to support structured reading and quick comparison.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# Executive summary

Agentic market intelligence applies AI agents to continuously gather, interpret, and communicate market signals, while preserving provenance and enabling supervised action. For specialty chemicals, the goal is strategic agility: detect changes early, translate them into chemistry and compliance implications, and respond faster than the market cycle. Unlike generic business intelligence, agentic market intelligence must be constraint aware. Chemistry, qualification, and regulation determine what is feasible and what is compliant.[8,10,18]

- Technology adoption is accelerating: Gartner forecasts that 40% of enterprise applications will feature integrated task-specific AI agents by end-2026, up from less than 5% in 2025.[8]
- Automation potential is large for knowledge work: analysis suggests generative AI and related technologies could automate work activities that absorb roughly 60% to 70% of employees' time, depending on role and task composition.[15]
- Market scale remains significant: public estimates place global specialty chemicals near one trillion US dollars in 2024 with mid-single-digit growth to 2030, while India's specialty chemicals market is also projected to expand through the decade.[26,27,1]

**Moves that CXOs can consider over the next 12 to 36 months as agentic AI proliferates:**

- Define where agents will change decisions: select a small set of decisions where speed, evidence, and compliance matter, such as regulatory readiness, substitution under constraint, and should-cost driven negotiations.[10]
- Extend MI from market sensing to resilience decisions: In supply-constrained environments, agents can connect external disruption signals with inventory coverage, sourcing alternatives, infrastructure constraints, procurement choices, and allocation decisions. The LNG illustration in this updated edition shows how strategic buffer design and operational response can work together to improve resilience when physical supply is disrupted.
- Build the evidence layer first: curate authoritative sources for regulation, trade, and standards; establish provenance rules and a source tiering approach so outputs remain verifiable.[18,20,24]
- Treat substance identity and taxonomy as a strategic asset: invest in synonym mapping, substance-class relationships, and jurisdiction-aware identifiers to reduce costly false matches.[3]
- Institutionalize evaluation and governance: introduce benchmark tasks, red-teaming, and change control; align to recognized AI risk management and security guidance.[10,11,12]
- Strengthen India-specific levers: use India's rapidly growing developer ecosystem and emerging digital public infrastructure where applicable to accelerate build and integration.[16,17]

Companion exhibits: Exhibit 1–3 cover market sizing and segment growth; Exhibit 4 illustrates enterprise adoption forecasts for task-specific agents; Exhibit 5 provides an illustrative MI signal mix; Exhibit 6 provides an illustrative evaluation scorecard.

# 01 Specialty chemicals industry landscape

Specialty chemicals are value-added formulations and performance materials sold on function rather than on commodity purity alone. They include ingredients and materials that enable downstream products such as crop protection solutions, pharmaceuticals, packaging, consumer products, batteries, displays, and semiconductors. Competitive advantage is typically built through proprietary process capability, quality systems, application support, and the ability to meet customer-specific specifications at scale.[26,3]

The sector's economics tend to be relationship and capability driven. Differentiation is often expressed through performance at low dosage, improved stability, compliance with tighter standards, and reliability of supply. This is why intelligence needs are broader than market sizing: teams need to understand how technical and regulatory shifts are changing customer qualification criteria and value perception.[3,21]

## 1.1 India: growth drivers, clusters, trade exposure, and structural advantage

Public sources highlight India-specific drivers: rising domestic consumption across downstream industries; policy focus on manufacturing and exports; investment in chemical clusters; supply chain diversification; and gradual shifts toward greener chemistries. Analyses also highlight headwinds such as China-linked pricing cycles, inventory corrections, and demand softness in some downstream categories. In this environment, early-cycle signal detection matters because response windows can be short.[1,5,6,7]

Trade intelligence is especially valuable for India because export competitiveness and import dependence vary by molecule and corridor. Government datasets can be used to monitor shifts in import dependence, export growth, corridor concentration, and unit value trends. These datasets are foundational for agents that must detect early shifts and translate them into product, supplier, and customer implications.[24,25]

India is also structurally positioned to build agentic capabilities. GitHub's Octoverse reports India as the fastest-growing developer population and expects India to become the world's largest developer population on GitHub by 2028. In agriculture, a key downstream for agrochemicals, India is building digital public infrastructure such as the AgriStack UFSI API gateway, which can increase availability of standardized, consent-based datasets for demand sensing.[16,17]

## 1.2 Global: regulatory tightening and sustainability expectations

Globally, specialty chemicals decision making is increasingly shaped by regulation and sustainability. The EU's Chemicals Strategy for Sustainability is linked to a 2050 climate-neutral and circular economy ambition and signals higher expectations for safer chemical substitution and transparency. Substance restriction proposals such as PFAS under REACH illustrate how whole chemical families can become commercially constrained, with ripple effects across electronics, coatings, textiles, packaging, and other end markets.[21,22,18,19]

In the United States, TSCA remains a central instrument for chemical reporting, testing, and restrictions. For companies serving global customers, agents must track updates across jurisdictions, understand how they differ by use case, and communicate implications with conservative confidence when evidence is incomplete.[20]

## 1.3 Segment lens to understand the intelligence needs

The report uses five segments to illustrate how market intelligence requirements vary by science, market structure, and regulatory exposure.

The five segments remain the core specialty-chemicals lens used throughout this report. A separate LNG example is included later as an adjacent-industry illustration rather than as an additional specialty-chemicals segment. Its purpose

is to demonstrate how the same decision-led agentic-MI principles can be adapted to a different high-stakes operating environment in which geopolitical signals, physical supply constraints, inventory resilience, and allocation decisions are tightly interconnected.

Table 1

## Segment-wise

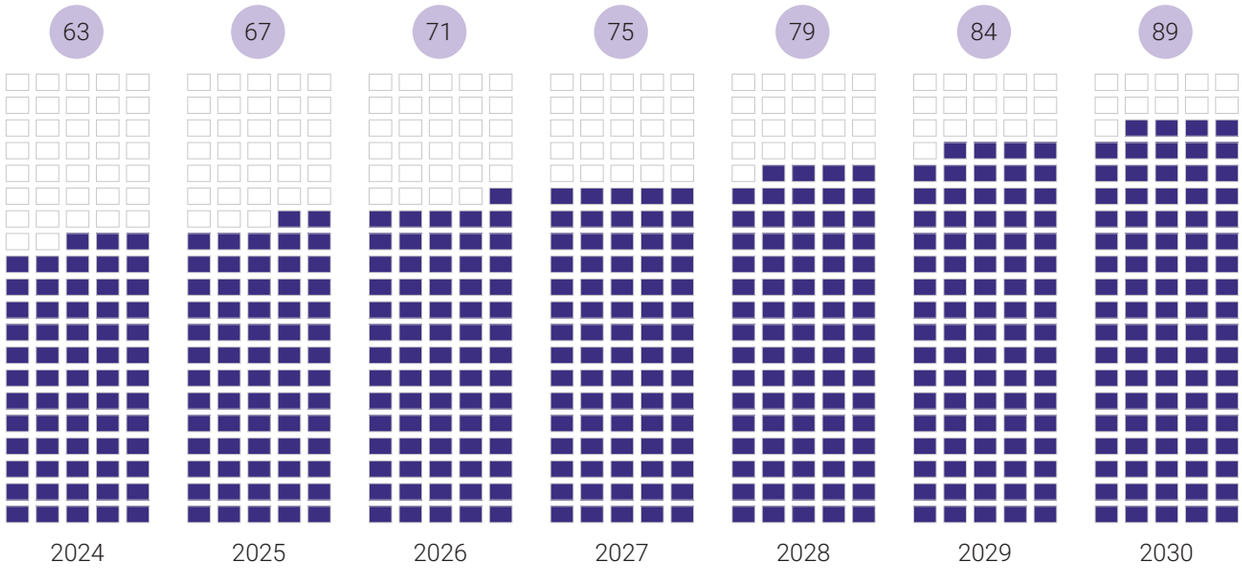
| Segment | What it includes | Typical intelligence needs |
|---|---|---|
| Agrochemical intermediates and crop protection | Intermediates, formulations, off-patent actives, adjuvants | Seasonality, pest and weather signals, residue standards, registration constraints, trade shocks |
| Pharmaceutical specialty ingredients and excipients | Excipients, functional polymers, specialty solvents, CDMO-linked intermediates | Auditability, pharmacopeial changes, inspection actions, shortages, therapy mix shifts |
| Peptides and peptide-related ingredients | Synthetic peptides, protected amino acids, coupling reagents, CDMO services | Process sensitivity, impurity control, regulatory guidance, pipeline signals, capacity constraints |
| Polymer additives and specialty polymers | Stabilizers, plasticizers, flame retardants, impact modifiers, functional resins | End-use swings, restriction risks, circularity requirements, substitute availability |
| Electronic chemicals and materials | High-purity solvents, etchants, photoresists, CMP slurries, specialty gases | Qualification cycles, yield sensitivity, geopolitics, purity specs, fab ecosystem signals |

See Exhibits 1–3 for market sizing and segment growth context.

Exhibit 1

## India specialty chemicals market

Below chart shows an implied market path from 2024 to 2030. Units are US$ billions. Values are derived from a 2030 market size estimate and an assumed constant CAGR to interpolate intermediate years.

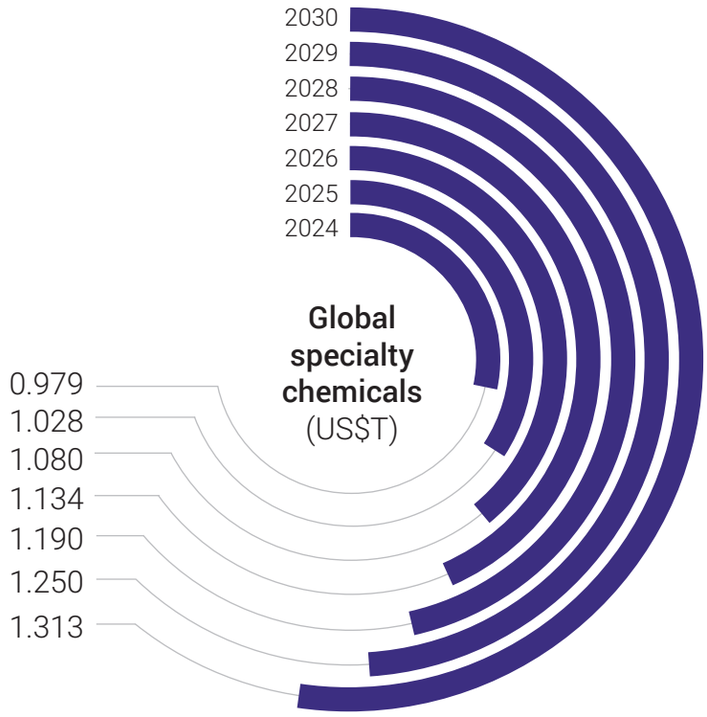



Source: Grand View Research (India specialty chemicals market outlook to 2030)

Exhibit 2

## Global specialty chemicals market

Below chart shows an implied market path from 2024 to 2030. Units are US$ trillions. Values are interpolated between published 2024 and 2030 estimates using a constant CAGR.

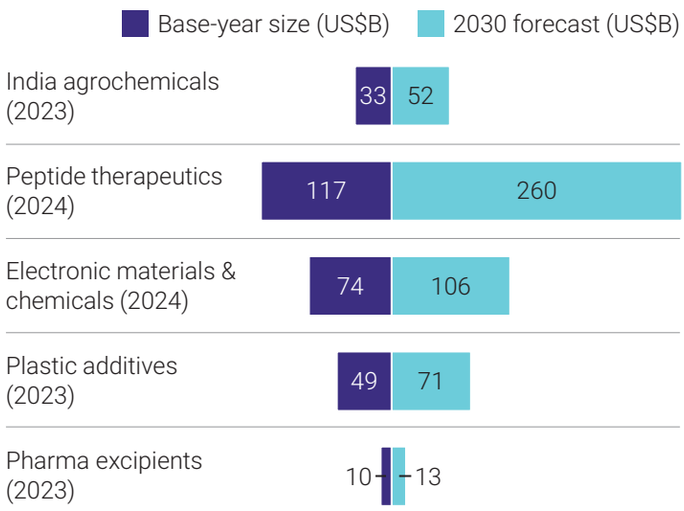



Source: Grand View Research (global specialty chemicals market to 2030)

Exhibit 3

## Segment size vs 2030

Below chart compares base-year size vs 2030 forecast for selected specialty segments. Units are US$ billions. Base years differ by source and are noted in the labels.

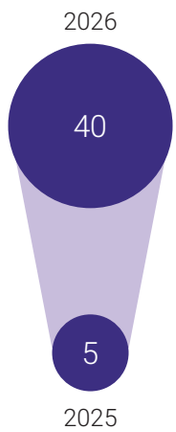



Source: Grand View Research; MarketsandMarkets

Exhibit 4

## Enterprise AI agent adoption

Below chart shows Gartner's forecast of the share of enterprise applications with integrated task-specific AI agents by end-2026. Units are percent of enterprise applications. The 2025 value is plotted at 5% to represent "less than 5%" as stated by Gartner.




Source: Gartner press release (Aug 26, 2025; updated Sep 5, 2025)

# 02 Sector understanding: Intelligence needs by segment

## 2.1 Agrochemical intermediates and crop protection

Agrochemical markets combine technical complexity with short-cycle demand volatility. Demand is shaped by weather variability, pest incidence, crop price realizations, resistance patterns, and policy actions. Intermediates and formulations face regulatory scrutiny driven by residue limits and environmental safety. This creates a distinctive intelligence requirement: signals must be linked to molecules, geographies, crop calendars, and registration constraints.[28]

**Illustrative agent modules (examples):**

- Crop demand and weather signal agent: monitors rainfall anomalies, acreage shifts, and pest signals, then translates them into molecule and geography demand hypotheses.[17]
- Regulatory and residue standards agent: tracks restrictions, residue limit updates, and registration changes, then flags implications for inventory and customer portfolios.[23,18]
- Trade corridor and exporter discovery agent: detects shifts in exports and imports by corridor and identifies alternative supplier clusters for constrained intermediates.[24,25]

## 2.2 Pharmaceutical specialty ingredients and excipients

Pharma-linked specialty ingredients sit in a high-trust value chain where quality, documentation, and auditability are central. Excipients and formulation ingredients form a multi-billion-dollar global market, and demand can shift with therapy mix, shortages, and formulation changes. Market intelligence must fuse signals such as pharmacopeial updates, inspection actions, shortage notices, and changes in customer qualification requirements.[33,34,20]

**Illustrative agent modules (examples):**

- Drug pipeline and formulation change agent: monitors therapy pipeline signals and formulation trends, then identifies potential demand shifts for excipients and specialty solvents.[9]
- Quality and audit readiness agent: assembles evidence packs from standards and regulatory sources to support customer audits and questionnaires.[20]
- Shortage and supply continuity agent: tracks shortage signals and supplier incidents, then maps exposure to critical grades and customer programs.[6]

## 2.3 Peptides: high-growth, high-precision manufacturing

Peptides represent a category where specialty chemistry meets biopharma growth. Public market estimates indicate strong growth for peptide therapeutics in the second half of the decade. From a market intelligence standpoint, peptides amplify the need for rigorous evidence because decisions depend on synthesis technologies, impurity control, and evolving regulatory guidance. Manufacturing guidance emphasizes control of synthesis steps, specifications, and analytical characterization.[29,30]

**Illustrative agent modules (examples):**

- Peptide pipeline and capacity agent: tracks demand pipeline and CDMO capacity moves, then flags implications for protected amino acid and reagent demand.[29]
- Impurity risk and comparability agent: monitors guidance updates and scientific literature, then flags comparability requirements and risk of substitution claims.[30]
- Supplier qualification agent for sensitive inputs: scans exporter and compliance signals for protected intermediates and key reagents.[24]

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## 2.4 Polymer additives and specialty polymers

Polymer additives enable performance, durability, and compliance across packaging, automotive, construction, and electronics. Global market estimates suggest mid-single-digit growth.
The segment faces rapid evolution in requirements driven by circular economy goals, recycling compatibility, and restrictions on certain substances. Market intelligence must connect regulatory and sustainability changes to formulation feasibility and supply continuity.[31,21]

**Illustrative agent modules (examples):**

- Restriction and substitution agent: tracks substance restrictions affecting additives and plasticizers, then proposes substitution pathways with constraints.[21,22]
- End-use demand sensing agent: monitors construction and automotive indicators to anticipate additive demand swings.[6]
- Circularity requirements agent: monitors packaging and recycling requirements that influence additive selection and compliance.[21]

## 2.5 Electronic chemicals and materials

Electronic chemicals demand ultra-high purity and tight process control. Market estimates indicate growth in electronic materials and chemicals through 2030. Market intelligence must incorporate qualification cycles, yield sensitivity, and geopolitical exposure.[32]

**Illustrative agent modules (examples):**

- Semiconductor ecosystem monitoring agent: tracks fab announcements, capacity investments, and localization initiatives, then maps material demand implications.[32]
- Qualification and spec change agent: monitors changes in purity and process specs and flags where upgrades or new grades are needed.[32]
- Geopolitical supply risk agent: monitors corridor risks and restrictions affecting specialty gases and high-purity inputs.[6]

See Exhibit 3 for segment growth comparisons and Exhibits 1–2 for market sizing context.

## 2.6 Adjacent-industry illustration: LNG inventory resilience and market intelligence

LNG provides an adjacent-industry illustration of how market intelligence becomes critical when geopolitical exposure, supplier concentration, infrastructure constraints, price volatility, and inventory depth interact. India's experience during the 2026 supply disruption highlighted this challenge: substantial regasification capacity did not by itself provide resilience when available storage coverage and supply-route flexibility were limited.[39] For market intelligence, the relevant question is therefore not only whether supply is available, but how quickly an external disruption translates into inventory, cost, network, and demand-allocation implications.

**Illustrative agent modules (examples):**

- Geopolitical and supply-corridor risk agent: Monitors producer-country concentration, geopolitical events, shipping corridors, cargo disruptions, and supplier availability, then assesses potential impact on landed supply and inventory coverage.
- Strategic inventory and resilience agent: Combines demand, storage capacity, current inventory, replenishment lead times, and disruption scenarios to assess buffer adequacy and identify resilience gaps.
- Supply-and-demand response agent: Connects available inventory, expected cargo arrivals, terminal/network constraints, price signals, and sector demand to identify emerging shortages and support procurement, network, and allocation decisions.

# 03 Market intelligence in specialty chemicals: What makes it hard, and what good looks like

Specialty chemicals market intelligence must connect what is happening with what is feasible. The same external event can produce different implications depending on grade-specific qualification, plant capability, and regulatory eligibility. Good market intelligence therefore requires a coherent entity model, provenance-controlled evidence, and constraint-aware interpretation.[3,5]

## 3.1 Signal fragmentation across structured and unstructured sources

Signals are distributed across trade statistics, pricing indices, regulatory notices, patents, scientific literature, sustainability disclosures, and market commentary. Many are unstructured and require extraction and linking to a consistent entity model. Substance synonym mapping and jurisdiction-aware classification are foundational.[24,25,23]

## 3.2 Slow ground truth and hidden dependencies

Qualification cycles, long contracts, and hidden failures delay learning. Dependencies run deep: a restriction on a substance class can affect multiple product families; a yield issue can constrain supply to key customers; a single-source intermediate can create systemic portfolio risk. Market intelligence systems should preserve provenance and express uncertainty explicitly.[21,22,10]

## 3.3 Compliance and sustainability as strategic signal streams

Sustainability and chemical safety have become strategic constraints. European policy direction and restriction proposals show how quickly requirements can rise from niche concerns to binding constraints. For suppliers, market intelligence must anticipate customer questions, build auditable evidence packs, and support substitution exploration where risk is rising.[21,22]

## 3.4 How market intelligence is typically done today

In many specialty chemicals organizations, market intelligence is assembled through a combination of analyst reports, trade press and journals, distributor feedback, customer conversations, patent and publication searches, and regulatory monitoring. The approach can be effective for strategic narrative building but can struggle with timeliness, traceability, and cross-functional reuse. Common pain points include fragmented data, inconsistent taxonomies, and limited institutional memory.[3,6]

Table 2

**Traditional MI building blocks and typical limitations**

| Traditional MI input | Strengths | Common limitations in specialty chemicals |
|---|---|---|
| Analyst reports and market studies | Structured market sizing and narratives | Lagging updates; limited molecule-level traceability |
| Trade press, journals, conferences | Early signals of technology and competitor moves | Noise; inconsistent coverage; difficult to operationalize |
| Patent and publication searches | Innovation visibility and technical evolution | Time consuming; hard to link to commercial exposure |
| Regulatory monitoring by experts | High quality interpretation | Manual; difficult to scale across jurisdictions; evidence packaging overhead |
| Distributor and sales feedback | Ground truth on pricing and demand | Bias; uneven coverage; limited cross-functional reuse |

## 3.5 Strategic vs operational market intelligence

A practical way to organize market intelligence is to separate strategic market intelligence from operational market intelligence. Strategic MI supports portfolio and investment decisions with longer horizons. Operational MI supports near-term decisions such as allocation, contract actions, and compliance responses. Both benefit from agents, but the evaluation and governance burden tends to be higher for operational MI because actions are closer to execution.[10]

Table 3

**Strategic MI vs operational MI**

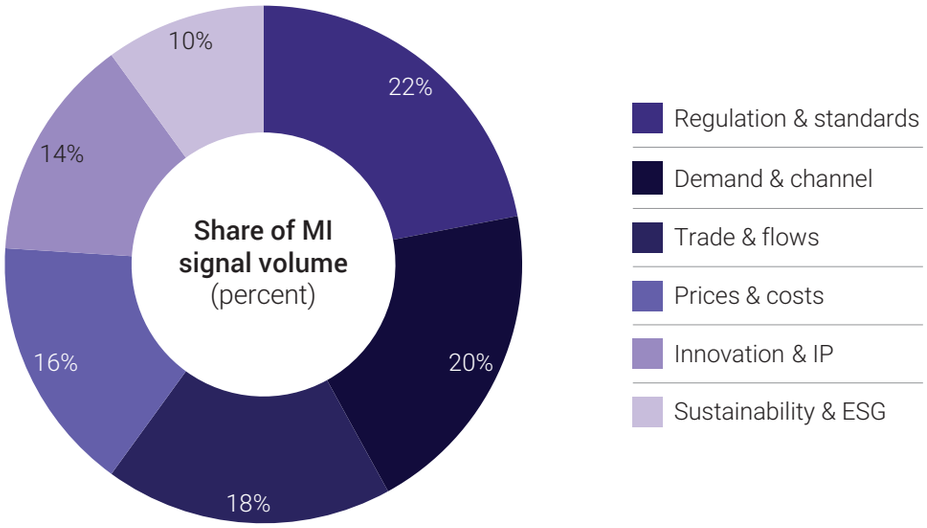
| Dimension | Strategic MI | Operational MI |
|---|---|---|
| Typical decisions | Portfolio adjacencies, capex, segment bets | Substitution under constraint, contract action briefs, compliance readiness |
| Time horizon | Quarterly to multi-year | Daily to monthly |
| Tolerance for error | Moderate if uncertainty is explicit | Low; can trigger immediate cost or compliance exposure |
| Data needs | Broader external signals; scenario framing | Freshness, entity precision, traceability, workflow context |
| Agent emphasis | Synthesis and scenario logic | Detection, anomaly interpretation, alerting with rationale |

See Exhibit 5 for an illustrative MI signal mix.

Exhibit 5

## MI signal mix (Illustrative)

Below chart provides an illustrative distribution of MI signal volume by category for specialty chemicals. Units are percent share. This is a conceptual view to support discussion of source coverage and is not a market statistic.




Source: Conceptual (illustrative)



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# 04 From BI to agentic market intelligence

Business intelligence organizes data into dashboards and periodic reporting. Agentic market intelligence adds a planning and reasoning layer. Agents can decompose questions into steps, retrieve evidence from multiple sources, call analytical tools, reconcile conflicting information, and draft decision-ready outputs with confidence indicators. The most valuable use cases in specialty chemicals are those where multi-step reasoning and evidence preservation reduce time to decision and reduce error risk.[8,13,14]

## 4.1 What an MI agent is, in practical terms

In an enterprise setting, an agent combines a reasoning model with a planning loop, memory, and tool access. Tools include retrieval over curated corpora, structured query, and analytics routines. Memory includes task state and longer-term context such as entity maps and prior analyses. The differentiator is multi-step autonomy inside defined guardrails.[13]

## 4.2 Reference framework built on conceptual layers

A practical reference architecture separates four concerns: decision and workflow layer, knowledge and data layer, agent and reasoning layer, and evaluation and governance layer. This separation enables safe scaling by ensuring that changes to data and prompts do not silently change behavior without evaluation, and by keeping provenance and access control explicit.[11,10]

Table 4

**Reference architecture components and design intent**

| Layer | Core components | Design intent for specialty chemicals |
|---|---|---|
| Decision and workflow | Role-specific views, alerts, case tracking, approvals | Tie outputs to decisions such as substitution, contract actions, regulatory responses |
| Knowledge and data | Entity model, taxonomies, curated corpora, structured marts | Enable substance-level traceability and cross-source linking |
| Agent and reasoning | Planner, tool router, retrieval, reasoning, uncertainty handling | Make multi-step research repeatable, evidence-grounded, and constraint-aware |
| Evaluation and governance | Benchmarks, red-teaming, audit, change control | Control hallucinations, leakage, and compliance risk |

# 05 Methodology: Building MI agents for specialty chemicals

A robust agent program begins with decisions, then builds evidence, then builds reasoning. This section provides a structured methodology that technical teams can use to design agents that are safe, accurate, and useful for specialty chemicals business problems.[10,13]

## 5.1 Overall context: Data, Agent, Reasoning, Decision

A simple framing that helps teams align is to separate four layers. Each layer has distinct design questions and failure modes.

## 5.2 Decision framing and outcome definitions

Define the decision to be supported in business terms: the user role, the cadence, the consequence of an error, and acceptable response time. Translate this into measurable outcomes such as reduced time to qualify alternatives, fewer compliance escalations, improved purchase price variance, or faster response to customer questionnaires.

## 5.3 Evidence design: source tiers and provenance policies

Create a tiered evidence strategy. For high-stakes claims, require official sources. Regulatory evidence should prioritize official pages from ECHA and the European Commission for EU scope, DGFT for India trade policy, and the US EPA for TSCA scope. Trade signals should rely on government datasets. Encode this tiering into retrieval policies and output formatting so that outputs remain verifiable.[18,19,23,20,24,25].

## 5.4 Entity model and taxonomy design

Build an entity model that includes substances, intermediates, grades, and equivalence classes. Maintain synonyms and spelling variants, CAS mappings where appropriate, and relationships such as contains, derived from, and substitutable with constraints. Add a regulatory layer mapping substances to jurisdictions, restriction types, and compliance requirements. This reduces false matches and enables agents to explain why a signal matters.[18,20]

Table 5

**Four-layer framing for agentic MI**

| Layer | What it contains | Examples of design questions |
|---|---|---|
| Data layer | Curated sources, marts, entity models, freshness rules | Which sources are authoritative? How is freshness measured? How are entities resolved? |
| Agent layer | Planner, tool selection, memory, permissions | What actions are allowed? How are tool errors handled? What memory is retained? |
| Reasoning layer | Constraint checks, triangulation, uncertainty | How does the agent separate detection vs interpretation? When does it refuse? |
| Decision layer | Alerts, cases, approvals, human validation | Who owns the decision? What approvals are required? How is accountability retained? |

## 5.5 Data quality and freshness: newness, drift, and provenance

Data quality for market intelligence is not only accuracy. It is also freshness, lineage, and stability of definitions. Agents should be designed to treat data freshness as first-class context: a proposal is different from an adopted restriction; a dataset release may revise prior periods; and market estimates are inherently uncertain. Define freshness rules per source, implement checks for staleness, and use provenance indicators in outputs so users can judge confidence.[10,18]

## 5.6 Signal detection vs interpretation, anomalies, and alerting with rationale

High-quality market intelligence separates detection from interpretation. Detection finds what changed. Interpretation explains why it matters for specific products, customers, and constraints. Agents should explicitly represent both steps and avoid jumping to action without evidence. For anomalies, agents should propose plausible explanations, list missing evidence, and recommend next-best investigations. Alerting should include action options and the rationale for each option, with a clear confidence cue.[13,14]

## 5.7 Retrieval and reasoning patterns

Retrieval-augmented generation is a core pattern for grounding generation in documents. For market intelligence agents, retrieval should be combined with explicit reasoning steps: entity resolution before summarization; triangulation across independent sources for high-impact claims; and explicit uncertainty reporting. Tool use should be mandatory for computations, and outputs should preserve intermediate calculations to support review.[14,13]

## 5.8 Constraint and risk checks

Agents should incorporate constraint checks as first-class steps. Regulatory checks should validate jurisdiction, applicable use case, and status of proposals. Quality checks should consider whether a substitution is plausible given customer qualification and impurity constraints. In peptides, manufacturing guidance emphasizes characterization and analytical controls, which should limit what agents suggest as equivalent without supporting evidence.[30,22]

## 5.9 Typical roles and responsibilities (RACI)

A lightweight RACI clarifies accountability and reduces risk, especially when outputs influence compliance or customer commitments.

Table 6

**Illustrative RACI for agentic MI**

| Activity | Accountable | Responsible | Consulted | Informed |
|---|---|---|---|---|
| Define decisions, thresholds, and outcomes | Business owner | MI product owner | Domain SMEs, Risk/Compliance | Functional leadership |
| Curate sources, entity model, and taxonomies | Data owner | Data steward | Domain SMEs, Legal | MI users |
| Define agent policies (tools, permissions) | AI product owner | ML/AI engineering | Security, IT | Risk/Compliance |
| Evaluate and red-team agents | Model risk owner | QA / evaluation lead | Security, Domain SMEs | Executive sponsor |
| Approve changes and releases | AI governance committee | Change manager | Security, Legal, Data owner | All stakeholders |
| Monitor performance and incidents | AI product owner | Operations | Security, Data owner | Executive sponsor |

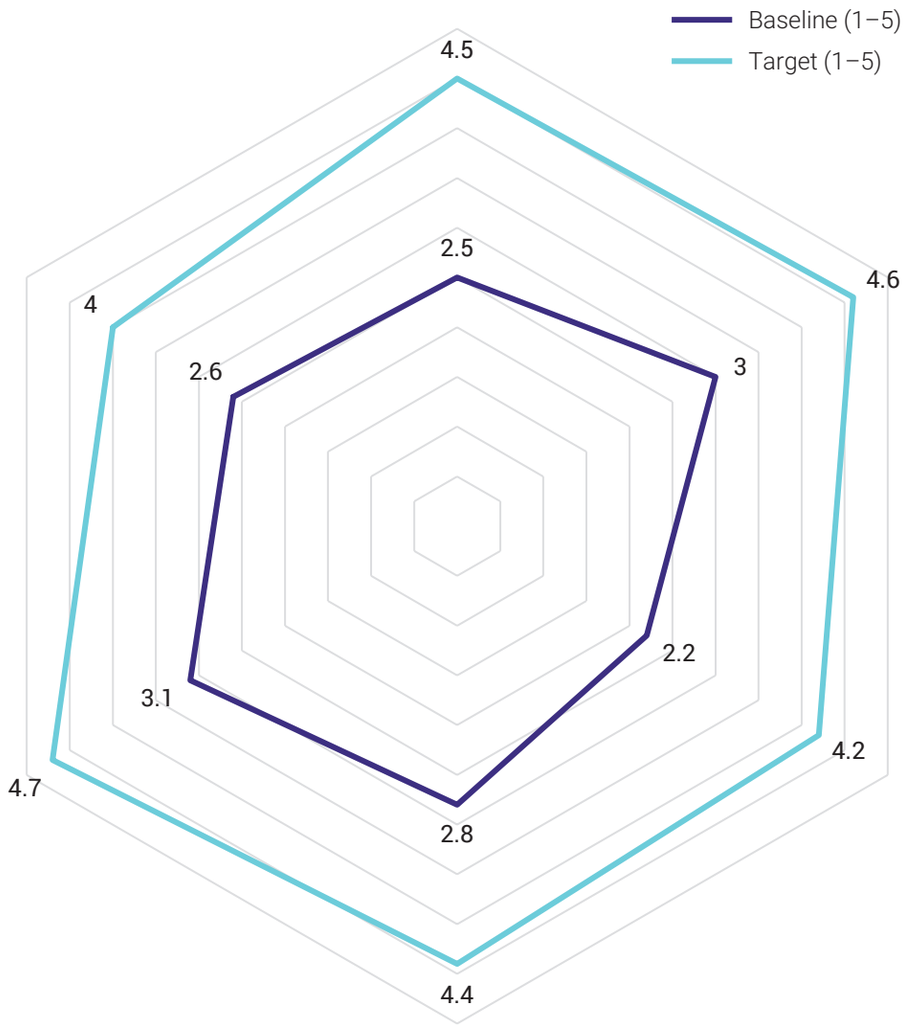
See Exhibit 6 for an illustrative evaluation scorecard chart.

Exhibit 6

## Evaluation scorecard (Illustrative)

Below chart illustrates an example evaluation scorecard using a 1–5 maturity scale. Baseline and target are illustrative and should be replaced with organization-specific evaluation results.

**Illustrative evaluation scorecard (1–5 maturity scale)**




Source: IBM Research; NIST AI RMF; OWASP

# 06 Design principles for agent building

Design principles translate business intent into consistent technical choices. They matter because agentic systems can appear capable even when they are wrong. In specialty chemicals, errors are costly. The principles below are written to keep agents grounded, conservative where necessary, and aligned to decision-making realities.[10,12]

Table 7

**Core design principles**

| Principle | Practical guideline |
|---|---|
| Decision-led outputs | Every output maps to a decision or investigation. Summaries exist only to reduce decision time or error |
| Evidence first, then narrative | Foreground verifiable facts with references; only then synthesize implications |
| Substance-level traceability | Reason over substances, synonyms, and classes, preserving an audit trail |
| Cross-source triangulation | High-impact claims require agreement across independent sources or explicit uncertainty |
| Constraint-aware reasoning | Regulatory, qualification, and safety checks are applied before suggesting actions |
| Human validation by design | Include human review gates for high-impact actions and document approval trails for accountability |
| Security and least privilege | Agents operate with minimal access; defend against prompt injection and data exfiltration |
| Evaluation-driven iteration | Model, data, and policy changes are versioned and re -evaluated before release |

# 07 Use case library tailored to specialty chemicals

The use cases below are organized by maturity. Foundational use cases institutionalize repeatable sensing and evidence packaging. Intermediate use cases add deeper reasoning and constraint handling. Advanced use cases combine multiple signals, scenarios, and cross-functional coordination. Within each tier, use cases can support strategic or operational market intelligence depending on how close they are to execution.[10]

## 7.1 Foundational use cases

### A. Multi-jurisdiction regulatory radar

**Decision intent:** Detect regulatory updates relevant to a portfolio and flag actionable exposure.[18,20,23]

**Primary signals:** Official notices and rulemaking pages, standards updates, restriction proposals.

**Typical outputs:** Actionable alerts; exposure summaries; evidence packs for internal review.

**Success measures:** Earlier compliance readiness; fewer late-stage escalations; faster internal decisions.

### B. Should-cost and negotiation intelligence

**Decision intent:** Provide procurement teams an evidence-based view of cost drivers and expected movements for key inputs.[24,25,23]

**Primary signals:** Feedstock and energy indices, trade unit value shifts, logistics indicators, tariff and policy updates.

**Typical outputs:** Cost driver decomposition; scenario ranges; negotiation-ready briefs with references.

**Success measures:** Improved purchase price variance; faster negotiation cycles; better contract timing.

### C. Supplier discovery for constrained intermediates

**Decision intent:** Discover and qualify alternative suppliers to reduce single-source dependence.[24,25]

**Primary signals:** Exporter lists, corridor concentration, compliance signals, public filings.

**Typical outputs:** Qualified supplier longlist; risk flags; suggested qualification steps; evidence pack.

**Success measures:** Reduced single-source dependency; improved continuity during shocks.

### D. Competitor capacity and reliability watch

**Decision intent:** Track competitor capacity moves, outages, and quality issues that may create supply gaps or pricing shifts.[6]

**Primary signals:** Trade flow anomalies, credible industry reports, incident and regulatory signals.

**Typical outputs:** Early warning alerts; competitor exposure narrative; recommended investigations.

**Success measures:** Lead time gained before market inflection points; improved response quality.

## 7.2 Intermediate use cases

### E. Segment whitespace and adjacency scouting

**Decision intent:** Identify adjacent products or grades that are technically feasible and commercially attractive, with a clear rationale for timing.[26,14]

**Primary signals:** Patents and publications, downstream growth indicators, trade shifts in adjacent molecules, competitor moves.

**Typical outputs:** Ranked adjacency list with evidence; constraints and risks; validation questions for technical teams.

**Success measures:** Reduced time to screen; higher conversion to viable programs; fewer late-stage feasibility surprises.

**F. Restriction impact and substitution analysis**

**Decision intent:** Assess how restriction proposals affect products and identify defensible substitution pathways.[22,21]

**Primary signals:** Proposal scope and timelines, affected end uses, equivalence constraints, customer requirements.

**Typical outputs:** Exposure heatmap; substitution pathways; uncertainty markers; customer talking points.

**Success measures:** Improved portfolio resilience; faster responses to customer queries; higher credibility.

**G. Segment demand sensing and allocation**

**Decision intent:** Detect demand inflections and support allocation decisions across constrained capacity.[28,24]

**Primary signals:** Downstream indicators, seasonality, trade flows, customer pipeline signals.

**Typical outputs:** Weekly narrative with indicators; allocation suggestions with confidence and rationale.

**Success measures:** Reduced stock-outs; improved utilization; less reactive discounting.

**H. Customer compliance pack generation**

**Decision intent:** Assemble evidence packs to answer customer questionnaires on substance safety and stewardship.[18,20]

**Primary signals:** Official regulatory sources, SDS references, internal composition and traceability data.

**Typical outputs:** Structured response pack with citations and traceability trail.

**Success measures:** Faster qualification cycles; reduced back-and-forth; higher audit readiness.

## 7.3 Advanced use cases

**I. Inventory risk from regulatory shifts**

**Decision intent:** Identify products at risk of inventory obsolescence due to restriction timelines or standards changes.[22,19]

**Primary signals:** Restriction proposals, customer timelines, internal inventory and shelf-life constraints.

**Typical outputs:** Risk-ranked inventory list; action suggestions; evidence pack for customer engagement.

**Success measures:** Lower write-offs; earlier customer alignment; smoother substitution planning.

**J. Peptide pipeline and manufacturing capability sensing**

**Decision intent:** Track therapeutic demand signals and manufacturing guidance that affect peptide-related ingredients and services.[29,30]

**Primary signals:** Market growth indicators, synthesis technology signals, guidance updates, capacity announcements.

**Typical outputs:** Quarterly demand narrative; critical input watchlist; evidence pack for investment discussions.

**Success measures:** Better timing of capacity investments; resilience on critical inputs; faster response to guidance changes.

**K. Electronic chemicals opportunity scouting**

**Decision intent:** Identify customers likely to qualify high-performance materials and prioritize outreach.[32]

**Primary signals:** Ecosystem updates, fab announcements, standards upgrades, localization signals.

**Typical outputs:** Ranked account list; hypotheses for technical sales; evidence pack for outreach.

**Success measures:** Higher win rate for premium grades; faster qualification; improved pipeline quality.

**L. Quality deviation intelligence and learning**

**Decision intent:** Link deviations to raw material variability and customer outcomes to identify systemic drivers.10

**Primary signals:** Internal quality records, supplier changes, complaint patterns, process parameter shifts.

**Typical outputs:** Root-cause hypotheses; preventive action suggestions; watchlists for at-risk batches.

**Success measures:** Reduced repeat deviations; improved customer satisfaction; lower rework rates.

**M. Inventory optimization: balancing cost and coverage**

**Decision intent:** Determine the appropriate level and timing of LNG inventory while balancing supply resilience, procurement cost, price exposure, and inventory carrying cost.

**Primary signals:** Current inventory and storage availability, demand forecasts, contracted and spot cargo positions, forward and spot LNG prices, supplier concentration, procurement lead times, and storage costs.

**Typical outputs:** Recommended inventory coverage range; procurement-timing scenarios; cost-versus-resilience trade-offs; supplier-diversification options; and alerts when projected inventory falls below defined resilience thresholds.

**Success measures:** Improved inventory coverage at optimized carrying cost; reduced exposure to emergency spot purchases and price spikes; lower supplier concentration; and fewer shortage events.

**N. Terminal and network optimization**

**Decision intent:** Optimize LNG flows across terminals and the downstream network to improve system utilization, reduce geographic concentration, and respond to localized capacity or supply constraints.

**Primary signals:** Terminal inventories, cargo arrival schedules, berth and regasification availability, terminal utilization, pipeline connectivity and constraints, regional demand, planned maintenance, and third-party capacity availability.

**Typical outputs:** Terminal and cargo-routing recommendations; inventory-rebalancing options; bottleneck and utilization alerts; inter-terminal cargo-sharing opportunities; and scenarios for improving system-level throughput and resilience.

**Success measures:** Higher terminal and network utilization; reduced congestion and avoidable logistics costs; improved regional supply availability; fewer localized shortages; and faster response to terminal or pipeline constraints.

**O. Dynamic demand allocation during scarcity**

**Decision intent:** Support transparent and economically efficient allocation of constrained LNG supply across demand sectors during shortage events.Primary signals: Available inventory and expected cargo arrivals, demand by sector, ability to switch fuels or defer consumption, criticality of supply, contractual commitments, alternate-fuel availability, and economic impact of curtailment.

**Typical outputs:** Scenario-based demand-supply balance; recommended merit order for curtailment; protected-demand categories; allocation options by sector; and rationale and confidence indicators for each recommendation.

**Success measures:** Faster scarcity response; continuity of supply to critical demand; reduced economic disruption; improved transparency of allocation decisions; and lower reliance on ad-hoc administrative rationing.

## 7.4 Interpreting impact: what to measure

A robust way to capture quantified impact is to measure outcomes rather than rely on anecdotes. For example, regulatory radar can be measured by lead time gained, compliance pack generation by cycle time reduction, should-cost by purchase price variance improvement, and demand sensing by service level and inventory volatility. As a broad benchmark for knowledge tasks, analysis suggests generative AI and related technologies could automate activities that absorb 60% to 70% of employee time. This informs the scale of opportunity, but each use case should be measured in context with guardrails.[15,10]

# 08 Evaluation and governance

Agentic market intelligence systems should be treated as high-impact decision support. Evaluation and governance are not add-ons. They keep outputs reliable, secure, and aligned to compliance expectations. In chemicals, incorrect regulatory interpretation or unsafe recommendations can lead to significant risk.[10,12]

## 8.1 Evaluation dimensions and practical metrics

Evaluation should be multi-dimensional. Some metrics are automated (grounding rate, tool success). Others require human judgment (decision usefulness). The key is to make evaluation repeatable, benchmark-driven, and tied to the decisions the agents support.[13,35]

- **Grounding and provenance:** percentage of decision-critical claims supported by retrieved sources.[13]
- **Tool success:** frequency of correct tool choice and error handling.[13]
- **Robustness:** performance under ambiguous substance naming and adversarial prompts.[13]
- **Decision usefulness:** time saved and confidence improvement for intended users.[13]
- **Safety and compliance:** rate of misstatements about regulation or safety constraints.[13]
- **Latency and cost:** runtime and compute cost versus operational targets.[13]

## 8.2 Governance frameworks and controls

Organizations can align governance to recognized frameworks. NIST's AI RMF provides a structure to map risks to controls. ISO/IEC 42001 defines an AI management system approach. OWASP's guidance highlights vulnerabilities such as prompt injection, insecure output handling, and data leakage. Governance should define roles, review gates, escalation triggers, and audit requirements appropriate to regulated decision contexts.[10,11,12]

## 8.3 Human validation and accountability

Human validation improves trust, accountability, and compliance. For high-impact decisions such as regulatory positions, customer commitments, and substitutions, agents should produce evidence packs and recommended options, but humans should approve the final action. Approval trails should be retained, and models should default to conservative behavior when evidence is incomplete.[10]

## 8.4 Data security and confidentiality

Agents can access privileged data through tools and therefore must be treated as credentialed identities with least-privilege permissions. Protect sensitive formulation data, customer specifications, and proprietary process information using policy enforcement, strong logging, and anomaly monitoring. Use allow-listed actions for tools, and test for prompt injection and data exfiltration paths through red-teaming.[12,10]

See Exhibit 6 for an illustrative evaluation scorecard chart. The chart uses a 1–5 maturity scale and is intended as an example, not as a percentage measure.

# 09 The next frontier of agentic AI for specialty chemicals (toward 2050)

Agentic AI is expected to become a common enterprise pattern, with rapid growth in task-specific agents. For specialty chemicals, relevance is amplified by the industry's complexity and by rising expectations on traceability, sustainability, and regulatory readiness. The long-term trajectory points toward deeper autonomy, multi-agent coordination, and tighter coupling between market sensing and scientific discovery.[8,9,21]

## 9.1 Toward 2050: closed-loop market-to-lab intelligence

A plausible 2050 frontier is the integration of market intelligence with autonomous discovery systems. Research on self-driving laboratories suggests that AI agents combined with automation can accelerate experimentation in chemistry and materials science. In specialty chemicals, this could enable a closed loop where market and regulatory signals trigger targeted lab exploration for substitutes, greener formulations, or improved process routes. Peptides and electronic materials are particularly suited because they demand high precision and benefit from tight control of synthesis and characterization.[36,37,38,30,32]

## 9.2 No-regret capabilities to build for companies

There are capabilities that create value under multiple futures because they improve market intelligence quality, speed, and auditability regardless of the level of autonomy. These no-regret moves also reduce risk as agentic capabilities expand.[10,11]

Table 8

**No-regret capabilities for agentic MI in specialty chemicals**

| Capability | Why it is no-regret | Examples of where it helps |
|---|---|---|
| Substance-level entity model and taxonomy | Reduces false matches and enables traceable reasoning | Regulatory radar, substitution analysis, compliance packs |
| Curated evidence layer with provenance | Improves verifiability and user trust | Regulation interpretation, customer Q&A, competitor watch |
| Freshness and quality rules by source | Prevents stale or mis-scoped conclusions | Restrictions vs proposals, revised trade datasets, index updates |
| Evaluation benchmarks and red-teaming | Controls hallucination and security risk | Adversarial prompts, ambiguous synonyms, tool failures |
| Human validation and approval trails | Preserves accountability for regulated decisions | Compliance positions, customer commitments, sensitive substitutions |

## 9.3 Key takeaways

- Agentic market intelligence is most valuable where decisions require multi-step evidence and constraint-aware interpretation, not just faster summarization.[13]
- Segment nuance matters. A single approach does not fit agrochemicals, pharma-linked specialties, peptides, polymer additives, and electronic chemicals.[28,29,31,32]
- Trust must be engineered: provenance, evaluation, and human validation are design requirements.[10,12]
- India has enabling conditions: a growing developer ecosystem and emerging data interfaces can accelerate capability building when paired with strong governance.[16,17]

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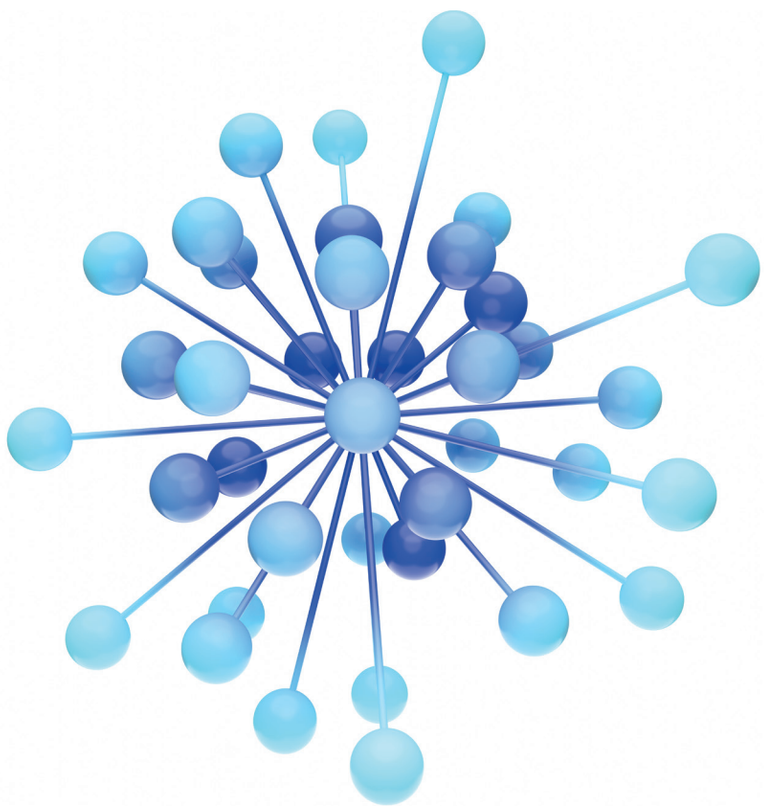

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