Catalysing new value streams in oil and gas with agentic AI

September 2025

The oil and gas (O&G) sector has historically relied on manual, siloed inspection processes. However, agentic AI has the potential to transform the industry with its autonomous decision-making capabilities. **Sumit Srivastav** and **Sagar Kothe** examine key agentic AI use cases across the O&G value chain that can effectively address the efficiency gaps in the sector.

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Overview

The global energy landscape is undergoing a significant transformation. Countries are implementing strict environmental regulations, and policymakers are incentivising renewable energy and electric vehicle (EV) adoption. The transition from traditional fossil fuels to more sustainable energy sources is expected to temper overall global oil demand, despite the growing demand from fast-growing economies in the developing world. Moreover, geopolitical tensions, volatile prices and ageing infrastructure have further intensified pressures on the O&G sector.

The sector, however, remains the bedrock of many economies. While O&G continues to dominate the global energy mix, the share of renewables is growing rapidly. In 2024, renewables accounted for the largest share of growth in global energy supply (38%), followed by natural gas (28%), coal (15%), oil (11%) and nuclear (8%).[1]

Thus, **O&G companies are navigating a world where value is shifting as climate change forces a fundamental rethink of how we fuel and power**. This has necessitated the adoption of business diversification strategies across the three stages of the value chain – upstream, midstream and downstream. For instance, oil companies are foraying into green hydrogen and renewables. One of India's largest O&G players has formed a joint venture with a waste-to-energy solutions company to set up compressed biogas (CBG) plants.

O&G companies, therefore, face a dual imperative: aligning with the global transition to clean energy while simultaneously addressing operational inefficiencies within their existing business models. In case of the Indian O&G sector, India's domestic crude oil production has been facing a steady decline, falling 2.5% year-on-year to approximately 26.5 million tonnes in 2024–2025. Without significant new discoveries, this downward trend is expected to continue.[2] As a result, the reliance on imports has intensified, with India importing nearly 88% of its oil and around 51% of its natural gas.[3]

Deepak Mahurkar
Partner – Oil and Gas
PwC India

> "Agentic AI would be the most effective safety partner for the O&G industry. Agent inspections, digital twins and automated shutdown protocols will anticipate hazards and intervene faster than any human, reducing risk and creating a truly proactive safety culture."

This scenario underscores the urgent need to bridge efficiency gaps across the value chain using advanced technologies. **Agentic AI, defined as AI systems capable of acting autonomously and executing tasks in dynamic environments, could play a pivotal role in enhancing the efficiency of oil exploration and production**.

For instance, O&G operations generate a vast amount of data across highly complex, safety-critical environments, but most of it lies unused. Many tasks (drilling calculations, maintenance scheduling, control-room monitoring) are highly recurring but need contextual judgement. That's where agentic AI can come in. Consider a refinery experiencing pressure anomalies. An AI agent can immediately detect them, run diagnostics, optimise flow parameters, notify stakeholders and adjust the operations – without the need for a human to intervene.

1 International Energy Agency, Global Energy Review 2025

2 The Economic Times, India's oil and gas production fall in 2024-25

3 Ibid.

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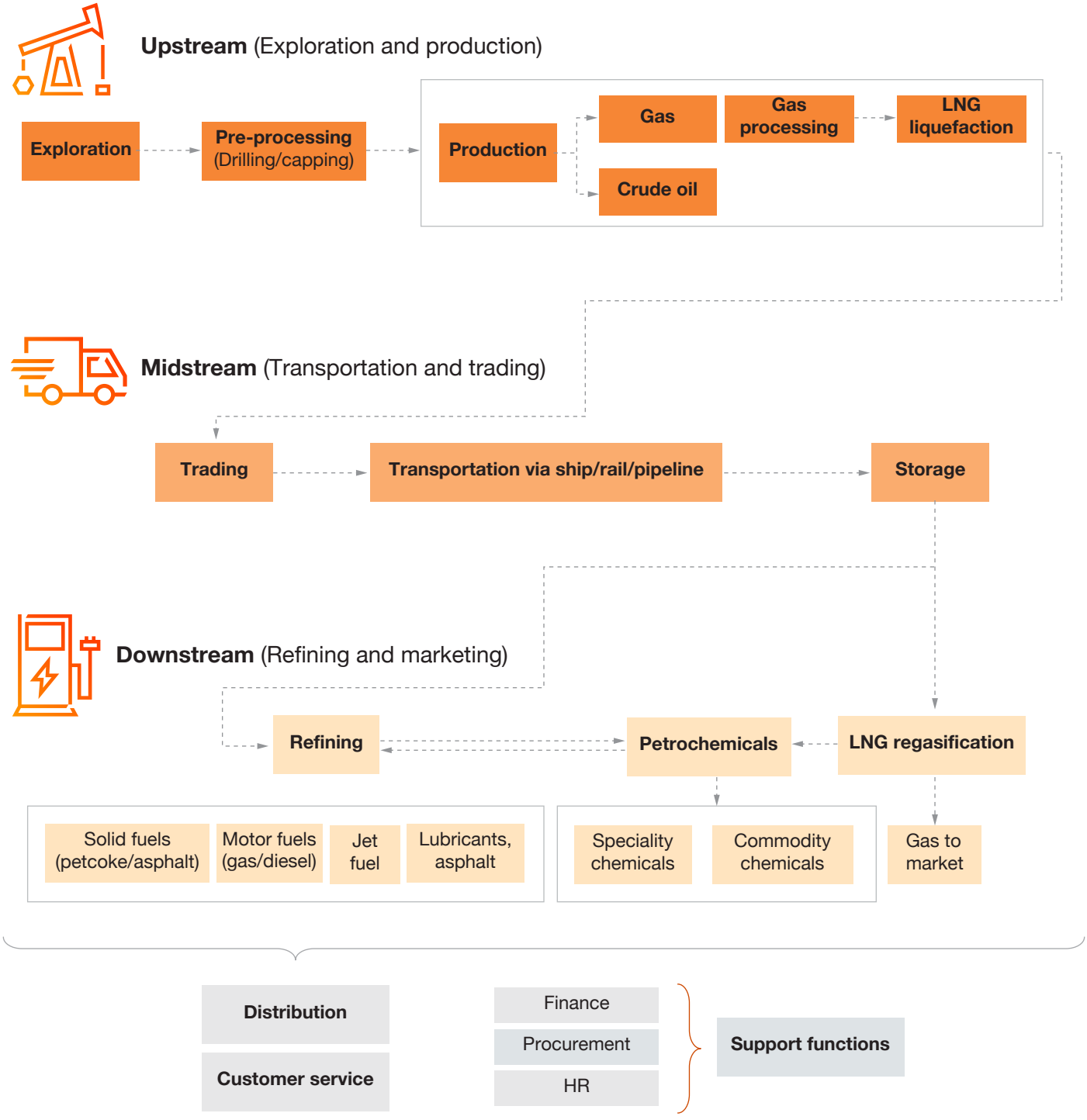
Our Take

Agentic AI in the oil and gas value chain

Agentic automation could address major pain points across upstream (exploration and production), midstream (transportation, trading) and downstream (refining, marketing) operations in the O&G value chain.

Figure 1: O&G value chain



Source: PwC analysis

2.1 Upstream operations: Potential agentic AI applications

Upstream operations in the O&G industry start with **exploration** where seismic data acquisition and processing enable identification of potential reserves. This is followed by **appraisal** which involves reservoir evaluation and fluid sampling to assess the volume of O&G resources. **Field development** includes well planning, drilling execution and asset optimisation, while **production** focuses on well operations for oil extraction, enhanced oil recovery techniques, asset integrity and maintenance. Lastly, **decommissioning** involves plugging and abandoning wells and environmental remediation to restore the site.

Agentic AI can play a pivotal role in all stages of upstream operations such as automating seismic data analysis, leveraging predictive analysis to optimise production strategies and AI-powered remediation planning.

Below are some of the potential applications of agentic AI which can help solve critical challenges in upstream operations:

Challenge	Agentic AI solution
1. High volume, complexity, noise and inaccuracies of seismic data	**A seismic data analyser agent** that autonomously processes raw seismic data, filters noise and generates enhanced subsurface images in real time.
2. High drilling costs due to dynamic downhole conditions, complicating manual adjustments and causing frequent human errors	**A drilling agent** that analyses well and reservoir data to optimise production rates by adjusting drilling parameters, wellbore instability, and pressure fluctuations.
3. Inefficient carbon capture and storage (CCS) operations leading to regulatory penalties	**An emissions monitoring agent** that autonomously reports and monitors emissions ensuring compliance with evolving regulations.
4. Reactive rather than proactive feasibility analysis and delays in integration of test results into decision-making	**A production testing and feasibility analysis agent** that continuously monitors test well performance, performs data analysis, and adjusts feasibility models on the fly, reducing the time between testing and decision-making.
5. Unplanned shutdowns and equipment failures disrupting operations	**An asset health monitor agent** that autonomously detects potential failures in drilling equipment by analysing historical data, detects wear and tear to prevent costly breakdowns.
6. Inefficient oil recovery due to poor monitoring and slow response to reservoir changes	**An enhanced oil recovery agent** that performs real-time monitoring and dynamically adjusts recovery parameters (such as carbon dioxide/water injection rates) based on reservoir behaviour and performance data.

2.2 Midstream operations: Potential agentic AI applications

Midstream operations involve safe and efficient transportation of O&G from production sites to refineries and consumers. The **gathering and processing** phase involves activities such as monitoring pipelines and facilities, gas compression and separation, liquefaction, fractionation and storage.

The **transportation** phase focuses on pipeline flow control and optimisation, managing pumping and compressor stations, coordinating fleet and trucking logistics, and overseeing marine and rail transport.

Agentic AI can enable easy tracking, detect leaks before they occur and help address issues such as vessel delays, improper routing and corrosion.

Following are some of the potential applications of agentic AI in midstream operations:

Challenge	Agentic AI solution
1. Corrosion posing a major challenge to maintaining pipeline integrity	**A corrosion loop agent** that analyses the dimensional data of all the loops in the pipeline unit to determine corrosion.
2. High operational load causing equipment overload and breakdown, resulting in production losses	**A freight movement optimiser agent** that forecasts the equipment strain and schedules preventive maintenance.
3. Improper freight management leading to inconsistent load distribution across trucks resulting in increase of idle time	**A truck loader agent** that autonomously analyses several trucks' movement data for uniform distribution of crude oil.
4. Improper vessel route planning and freight mismanagement causing port congestion and demurrage charges	**A maritime logistics agent** that analyses reports shared by sea focals and dynamically adjusts docking and loading/unloading schedules to reduce congestion at ports.
5. Fuel leak caused by human/technical error due to improper monitoring mechanism	**A fuel tank monitoring agent** that autonomously detects potential leakage in storage tanks by analysing historical data shared over a period of time.
6. Improper tracking mechanism to keep a check on inventory, leading to a huge gap between demand and supply	**A fuel inventory tracker agent** that analyses data regarding utilisation of the fuel available to maintain the demand and supply equation.

2.3 Downstream operations: Potential agentic AI applications

In the downstream operations of the O&G industry, **refining and processing** involves fractional distillation to separate crude oil into different components, catalytic cracking (conversion of heavier crude oils into more desirable products) and crude oil blending. **Supply and trading** focuses on product trading, price optimisation and transportation.

The last step involves **product marketing and retail** for refined products.

AI agents can optimise pressure, temperature and throughput to ensure efficiency, predict market demand across retail networks and make pricing recommendations based on real-time factors.

Following are some of the potential applications of agentic AI in downstream operations:

Challenge	Agentic AI solution
1. Feedstock variability resulting in refined product quality degradation	**A crude oil blending agent** that analyses chemical composition of crude oil derived from crude oil assays and suggests the blending ratio.
2. Inconsistent temperature and pressure leading to process inefficiencies during distillation and cracking	**A processing unit optimiser agent** that examines the variation in heat, pressure and flow rates during distillation and cracking process and provides optimal suggestions.
3. Inefficient storage utilisation leading to imbalance in demand and supply and increased costs	**A downstream storage optimiser agent** that analyses and helps in maintaining the utilisation of stored quantity to maintain balance between demand and supply.
4. Uneven supply across retail network causing supply-demand mismatch at retail outlets	**A retail data analyser agent** that evaluates sales data and available stocks to prevent inventory from going out of stock in retail shops.
5. Pricing pressure due to market fluctuations	**A market and competitor analysis agent** that monitors and analyses market intelligence sites to anticipate price trends.

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Agentic AI use cases

3.1 Corrosion loop maintenance agent

The O&G value chain relies extensively on the transportation of fuel through pipelines. However, corrosion – an inherent and undesirable consequence of fuel flow within these pipelines – continues to pose significant operational challenges. Current systems struggle to manage pipeline corrosion effectively. At present, the process of extracting and cleansing unstructured data for input into asset performance management (APM) tools is performed manually, and the configuration of APM systems also remains a manual task.

As-is activities in corrosion loop maintenance

The following activities form the foundational workflow of corrosion loop maintenance, ensuring that the asset data is digitised and structured within APM systems to monitor corrosion.

Piping and instrumentation diagrams (P&IDs) and isometric data extraction

The process starts with the user, typically an engineer or a technician, providing the P&IDs and isometric drawings which represent the plant's piping systems and equipment layouts in the system. The system analyses and extracts relevant data such as pipe sizes, materials, equipment locations and instrumentation points which are needed for corrosion monitoring.

APM tool configuration

Once the data is extracted, the user configures the APM tool. This involves setting up corrosion loops, inspection points and associated parameters within the APM software environment.

TML data manipulation

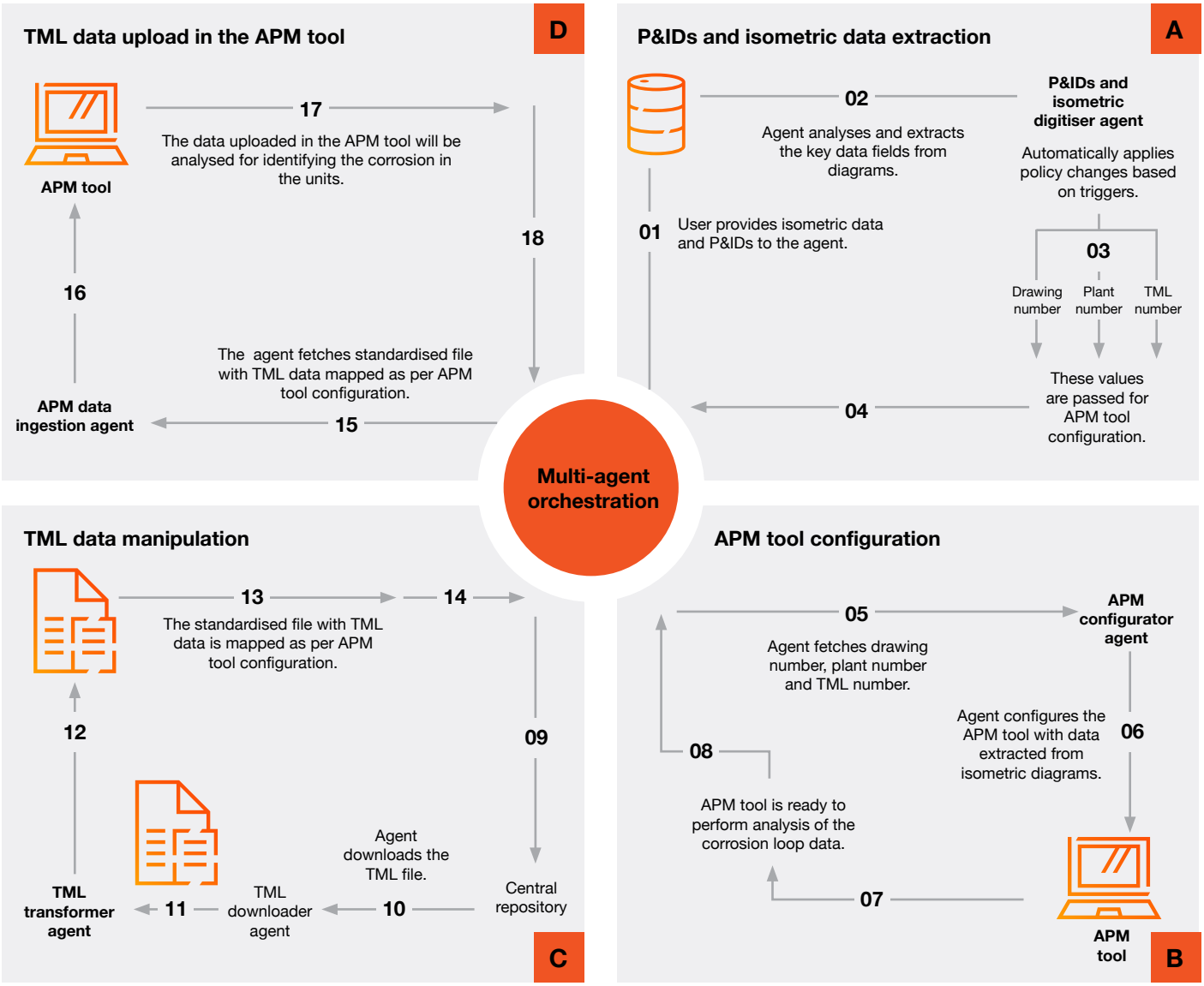
The thickness monitoring location (TML) data, which includes points on pipes or equipment where thickness is monitored to check the rate of damage and corrosion, is in an unstructured format. It needs to be manually cleansed and manipulated and transferred to a file format which the APM tool can understand.

TML data upload in APM tool

In the final step, the structured TML data is manually uploaded in the APM tool for it to perform corrosion analysis and generate reports.

Agentic AI has the potential to transform the corrosion maintenance loop workflow by automating it to enhance accuracy and enable intelligent decision-making. AI agents can automatically extract data from diagrams, streamline data workflow and automate APM set-up. Efficient data handling and analysis can lead to improved corrosion management (see Figure 2).

Figure 2: Multi-agent corrosion loop workflow



Source: PwC analysis

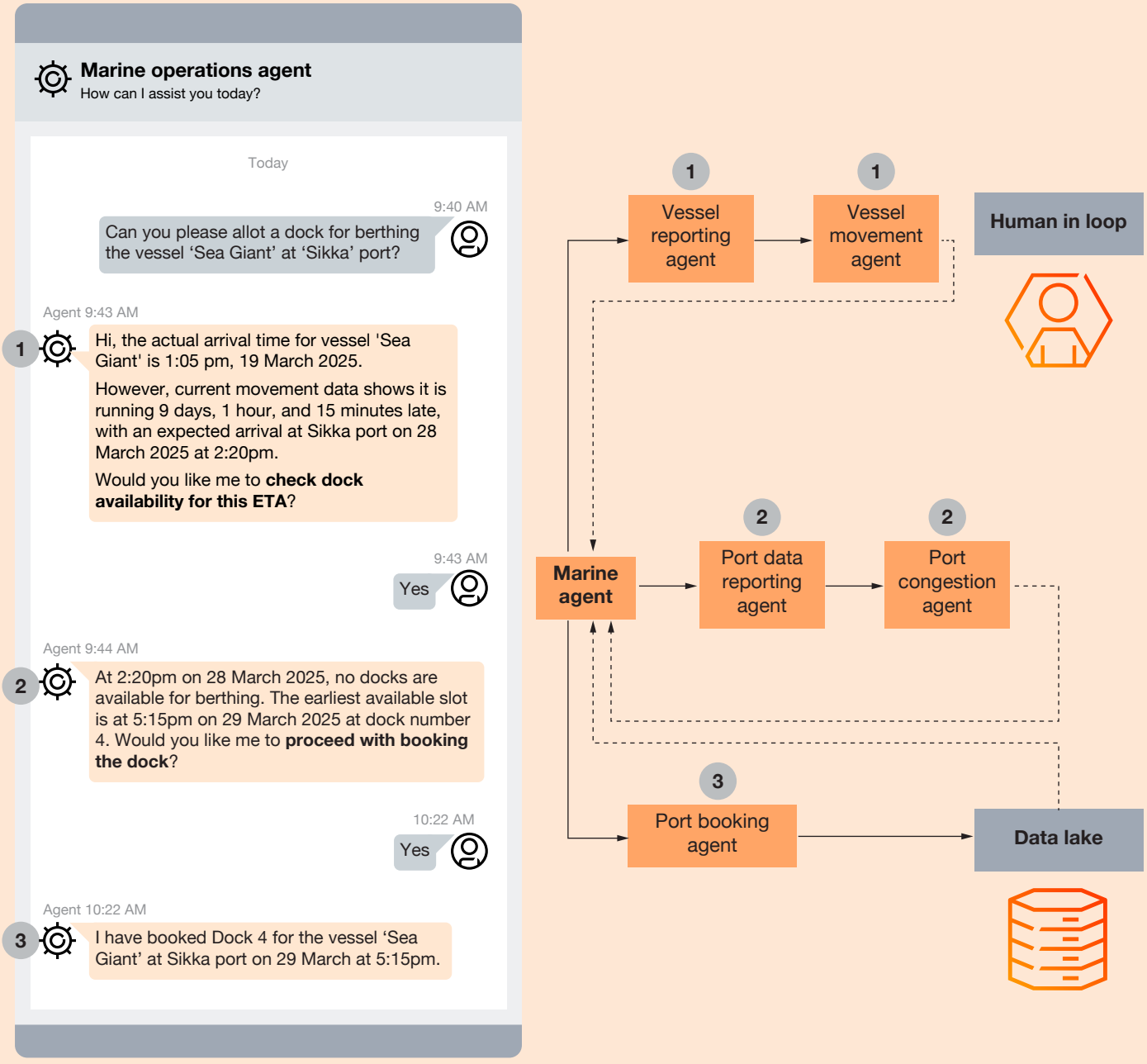
3.2 Marine operations agent

The marine operations manager plays a critical role in the O&G value chain by overseeing the shipping and logistics of crude oil, liquefied natural gas (LNG) and other commodities. Responsible for managing over 100 vessel movements each month, the role demands precise and timely decision-making. For instance, determining the optimal docking location for a tanker requires tracking berth availability, weather conditions, vessel estimated time of arrival (ETA), and potential demurrage charges. Rather than manually coordinating these variables, a marine operations manager working in tandem with an AI agent can simply pose the query to the system, which autonomously analyses the data and delivers an optimal solution within seconds.

Ken Brown
Partner and Technology Leader – Oil and Gas
PwC Middle East

“With the rise of agentic automation, enterprises are reimagining the art of the possible. In oil and gas, a highly data-driven sector, there is a drive to embrace this shift, with agents designed to work with humans, delivering improved value across the supply chain.”

Figure 3: Agentic AI-assisted maritime logistics workflow (1/2)
A day in the life of a marine operations manager, assisted by agents



Note: Illustration for demonstrative purposes only. Each number in the illustration corresponds to the AI agent/agents handling that query.
Source: PwC analysis

In Figure 3, we see how a marine operations manager asks the AI agent to allot a dock for the berthing of the vessel at a particular port. The query is processed by the agent and passed on to the vessel reporting and vessel movement agent.

The **vessel reporting agent** retrieves the last known position and timestamp and looks up vessel details like dimensions and cargo type. It then provides an ETA based on scheduled arrival communicated by the marine focal. The **vessel movement agent** runs a short-term predictive model to refine the ETA by considering factors such as current speed variations, sea conditions and potential slowdowns and comes up with an updated ETA.

The marine agent gathers both sets of information, presents the consolidated ETA and then inquires if the user would like to check berth availability.

Once the user responds in the affirmative, the **port data reporting agent** extracts information from the port-authority scheduling system and berth allocation database, checks booked slots, overlapping windows, vessel size compatibility and comes up with a list of next available berth windows. The port congestion agent computes a congestion index, including expected wait times, berth occupancy rates and generates a summary.

The marine agent then processes both sets of information to provide the earliest available slot and upon approval from the manager, proceeds to book it.

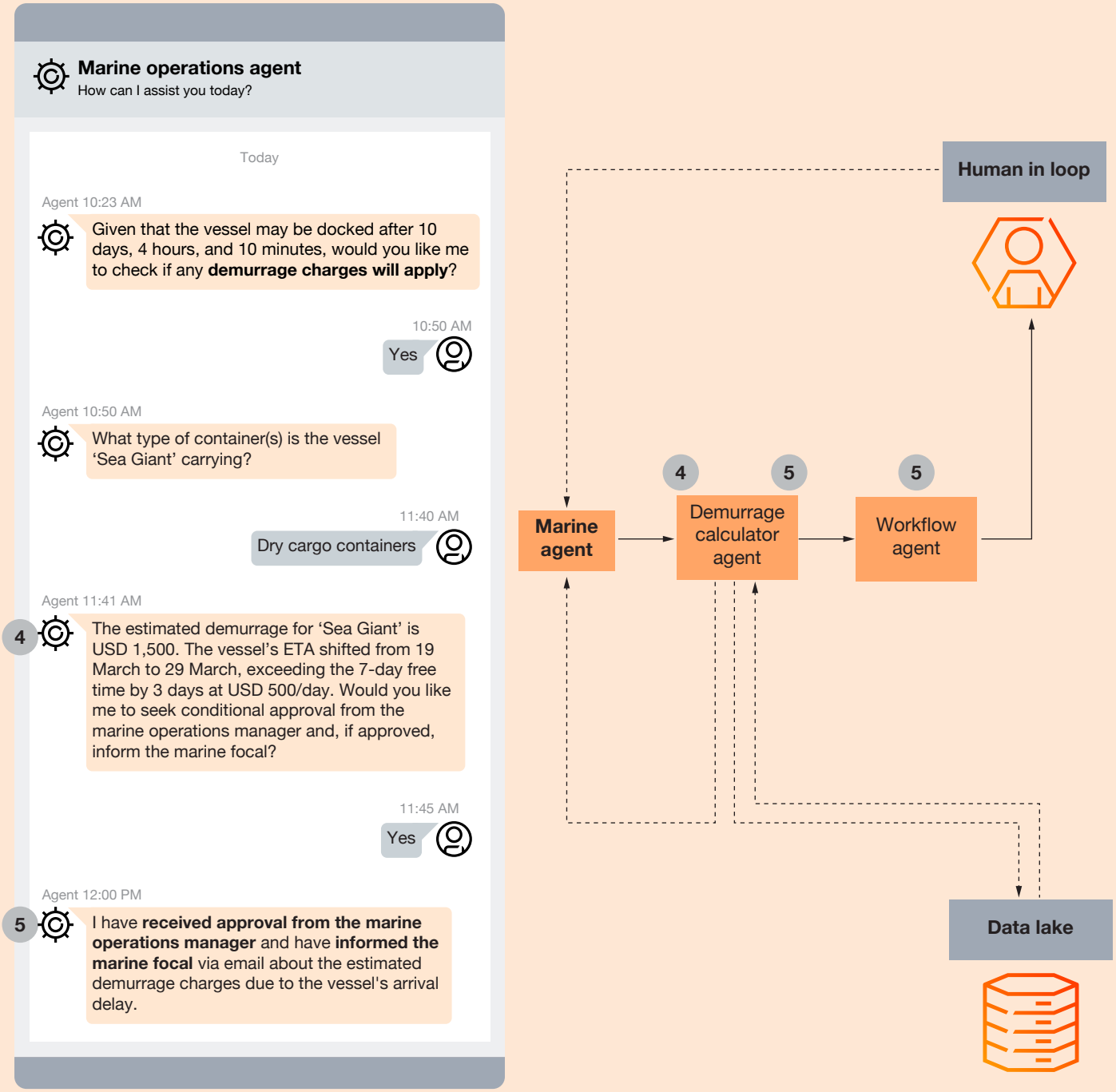
The **port booking agent** validates vessel credentials, checks for scheduling conflicts and records the booking in the data lake.

The marine agent then informs the manager that the berth has been secured.

Each of these sub-agents engages with the shared data lake and communicates with external systems such as automatic identification system (AIS) feeds, port application programming interfaces (APIs) and enterprise resource planning (ERP)/contract systems. This occurs in a fully orchestrated agentic automation pipeline yet the marine operations manager experiences it in a single, unified chat.

The marine agent further takes context-aware decisions and computes the demurrage charges, supporting strategic decision-making while keeping a human reviewer in the loop for oversight (see Figure 4).

Figure 4: Agentic AI-assisted maritime logistics workflow (2/2)
A day in the life of a marine operations manager, assisted by agents



Note: Illustration for demonstrative purposes only. Each number in the illustration corresponds to the AI agent/agents handling that query.
Source: PwC analysis

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Select recommendations

To fully harness the potential of agentic AI automation, organisations must adopt a well-defined strategy which integrates AI agents into the workforce, identifies high-impact use cases for piloting and scaling, and proactively addresses agent governance and data security considerations. Prior to implementation, it is recommended that companies carefully evaluate the following three critical dimensions to ensure responsible and effective deployment:

Define strategy and operating model

To effectively leverage agentic AI, leaders must establish a clear vision along with well-defined objectives for how these autonomous systems will drive impact across the organisation. Roles and responsibilities along with workflows need to be outlined to seamlessly integrate AI-driven decision-making with existing processes. Establishing performance metrics to monitor the impact and ensuring alignment with overall business goals are also critical.

Establish a centre of excellence (CoE) and governance setup

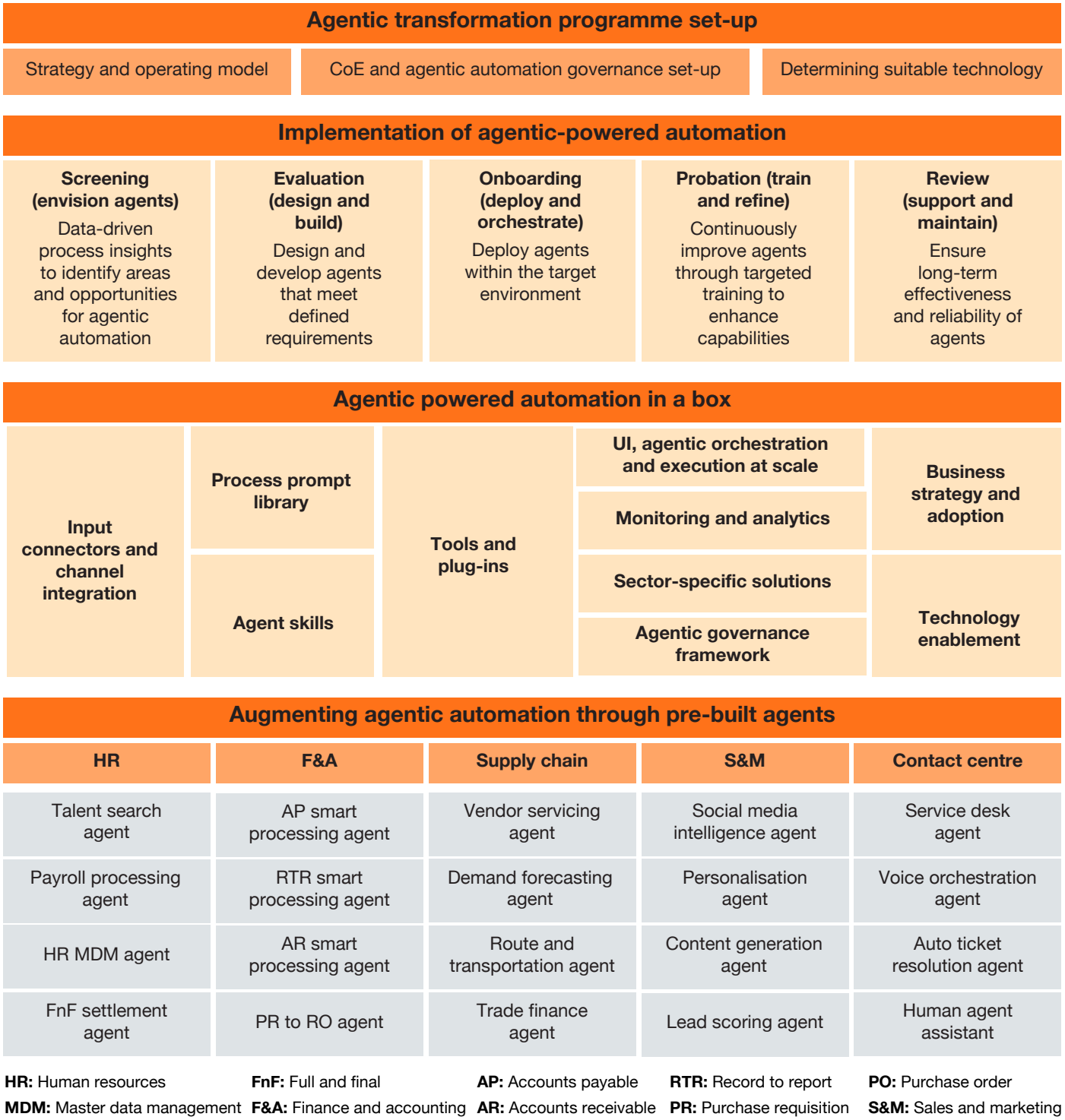
A CoE should be created to centralise expertise, best practices and resources dedicated to agentic AI development and deployment. Governance frameworks need to be implemented to ensure ethical use, compliance and risk management related to AI autonomy. Fostering collaboration between stakeholders can continuously refine policies and address emerging challenges.

Determine suitable technology

Leaders need to evaluate and select AI platforms, tools and infrastructure which support autonomous decision-making capabilities and scalability. Ensuring interoperability with current IT systems and data sources is imperative to enable seamless operation. Priority should be given to technologies with robust security features and transparency to build trust and accountability.

At PwC India, we help companies integrate agentic AI solutions to maximise operational efficiency. From identifying automation-ready use cases to designing custom agent architectures, training the workforce, deploying pre-built agents across business functions and ensuring governance and compliance – we partner with clients from blueprint to execution.

Figure 5: PwC India's proposed agentic AI set-up



HR: Human resources **FnF:** Full and final **AP:** Accounts payable **RTR:** Record to report **PO:** Purchase order
MDM: Master data management **F&A:** Finance and accounting **AR:** Accounts receivable **PR:** Purchase requisition **S&M:** Sales and marketing

Source: PwC analysis

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Looking ahead

In the O&G sector, the successful deployment of agentic AI hinges on two foundational elements: data readiness and upgraded/modernised infrastructure. Agentic AI systems require robust, high-quality datasets to make autonomous decisions. Fragmented or outdated data can lead to suboptimal outcomes and ineffective decision-making. Regularly updated datasets are essential to prevent model drift – where AI systems produce inaccurate responses when faced with unfamiliar scenarios or situations they haven't been trained on.

Multi-agent systems, particularly those managing end-to-end supply chain operations, demand structured, synchronised, multi-source datasets to function effectively. Therefore, it is imperative for companies to digitise records, cleanse data and implement strong data management practices.

Equally important is the modernisation of legacy infrastructure to support the computational and storage demands of advanced AI systems. As the industry evolves, O&G enterprises are increasingly positioned to tap into agentic AI capabilities to drive transformation – whether through enhanced resource discovery, risk mitigation, regulatory compliance or advancing sustainability goals.

Manas Majumdar
Partner and Leader – Oil and Gas
PwC India

"While we are in the midst of energy transition, the importance of the O&G sector in the energy mix remains significant. In this industry, data acts as the oil that fuels business activities across the value chain. In terms of energy security and sustainability, it is vital for oil companies to leverage advanced AI automation to derive actionable insights from data streams across the value chain."

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