HUB TECH IA

Deliverable report 33

AI and IAGEN Application Use Case

Continuous Improvement in the Vaca Muerta Oil Industry

I. Introduction

The oil industry in Vaca Muerta, Argentina, is in a constant state of search for optimization of its processes to maximize production and profitability.

In this site, rich in unconventional hydrocarbons, there are challenges that They demand innovative solutions. Continuous Improvement stands as a pillar essential for success in this environment.

II. Challenges

Operations in Vaca Muerta are characterized by:

- Geological variability: The heterogeneity of the Vaca Muerta formation implies that the characteristics of the wells vary significantly, which requires a constant adaptation of extraction techniques.
- High operating costs: Extraction of unconventional hydrocarbons It requires advanced technologies and complex processes, which translates into costs high operating costs.
- Data management: The volume of data generated in the operations of Drilling, extraction and production is massive, and its efficient analysis is crucial for decision-making.
- Safety and environment: The oil industry must operate under strict

safety standards and with minimal environmental impact.

III. IAGEN in Continuous Improvement

Generative Artificial Intelligence (GENAI) is a branch of artificial intelligence that focuses on creating new content, such as models, images, code, or text, from existing data. This technology uses advanced algorithms to analyze large amounts of information, identify patterns and generate new content and original that is often indistinguishable from that created by humans.

IAGEN is applied in Continuous Improvement in various ways, transforming the way in which data is analyzed, optimization opportunities are identified, and implement the improvements.

1. IAGEN Applications

- Historical data analysis: IAGEN can analyze large volumes of data extraction, maintenance, failure and operational incident histories for identify patterns and trends that are not obvious to the naked eye.
- Report generation: From data analysis, IAGEN can generate Customized reports with relevant information for each team and operation, highlighting specific points for improvement.
- Performance Comparison: IAGEN allows you to compare the performance of different wells, equipment or processes, identifying best practices and areas of chance.
- Document Automation: IAGEN can automate the generation of documents with recommendations adapted to each situation, facilitating the communication and the implementation of improvements.
- Optimization of material movement: IAGEN optimizes the logistics of the transportation for oil and gas companies. Analyze data to optimize routes and schedules of trucks, pipelines and ships, ensuring delivery efficient and timely while minimizing costs. In addition, IAGEN goes further beyond the predictive maintenance of machinery in general and extends its

experience to material handling equipment. Use supervision
advanced technology to predict equipment maintenance needs. This
proactive approach helps prevent breakdowns and ensures reliability of the
material handling operations.

- Exploration of new oil fields: IAGEN can be used to
  Identify potential oil deposits through data analysis
  geological and seismic.
- Regulatory Compliance: IAGEN can help ensure compliance with
  industry regulations by automating tasks, such as
  reporting and compliance monitoring.
- Improved subsurface data analysis: IAGEN can improve images
  to create 3D models. You can also generate subsurface images using
  fewer seismic data scans, avoiding the need for repeated
  data acquisitions to fill data gaps that are common in the
  upstream oil industry.

2. Reservoir simulation

Efficient reservoir management is crucial to maximizing production and
reduce costs in the oil and gas industry. IAGEN can be used to
Improve reservoir simulation by creating more accurate models and
the optimization of production strategies.

3. Improving health, safety and environment (HSE)

IAGEN can play a key role in improving the measures of
HSE in the oil and gas industry. By analyzing data from various
sources, IAGEN can identify potential hazards, predict risks and recommend
Preventive measures. This helps companies avoid accidents, spills,
environmental and other incidents, ensuring a safer and more secure working environment
more sustainable operations.

4. Data-driven decision-making

Oil and gas companies generate huge amounts of data, often
too large for humans to analyze efficiently. Here it is
where IAGEN shines. IAGEN can quickly analyze large data sets
data, providing valuable insights to help businesses make
smarter decisions. From optimizing supply chains to
resource management and planning for future projects, IAGEN keeps the
companies at the forefront.

5. Reduction of carbon emissions

IAGEN can play a role in reducing carbon emissions in
the oil and gas industry. By analyzing consumption data
energy, IAGEN systems can identify areas where operations
are using more energy than necessary. You can then suggest adjustments
to make processes more efficient, which translates into fewer emissions.

IV. Application of IAGEN-based agents in the activity

1. **Concept of IAGEN agents**

In recent years, generative artificial intelligence (GAI) has revolutionized the way we interact with
technology, enabling the development of systems
capable of generating content, answering complex questions and assisting with tasks
high-demand cognitive skills. From this capacity, a new architecture emerges
Technological: IAGen-powered agents. These agents are not simple
conversational interfaces, but autonomous systems that can interpret
instructions, make decisions, execute tasks and learn from their interactions with the
around.

An IAGen agent combines large language models with components
additional features such as external tools, memory, planning and autonomous execution.

This allows them to operate in complex environments, with the ability to break down Step-by-step objectives, coordinate multiple actions, interact with digital systems (such as databases, APIs or documents) and adapt to changes in context in real time. These qualities distinguish them from traditional chatbots, and open up a spectrum of more sophisticated and customizable applications.

At the organizational level, these agents are being used to automate processes, generate data analysis, assist in decision making and improve the user experience, both internally and externally. For example, they can assume human resources, legal, financial or logistical tasks, and even those linked to the technical areas of production processes, acting as intelligent assistants that collaborate with human teams. This ability to integrate knowledge and execute tasks autonomously transforms the way organizations can scale your operations without losing quality or control.

In addition, agentic workflows—structures where multiple agents collaborate with each other to solve complex problems—allow responsibilities to be distributed between different agent profiles, each with specific functions. This generates Hybrid work environments where humans and agents coexist, optimizing times, costs, and results. The ability to connect agents with tools such as Google Drive, CRMs or document management platforms further expands its capabilities.

The development of IAGen-powered agents represents a crucial step towards a new era of intelligent automation.

Among the benefits of authentic workflows driven by business models generative artificial intelligence, the possibility of automating processes is found complete, end-to-end production systems, and even add value from the leveraging the skills of language models based on these technologies.

However, its implementation also poses technical, ethical and legal challenges, from responsible design to human oversight. Therefore, understanding your architecture, its operational logic and its potential impacts is fundamental to its effective and safe adoption in various professional contexts.

2. Proposal for the design of a Continuous Improvement Agent based on IAGen

Applicable to: hydraulic fracturing plants, production, transportation, water treatment and integrated energy systems.

Objective: Detect patterns of inefficiency, anticipate failures, and generate knowledge actionable for constant operational improvement.

IAGen Agent Architecture

a. Intelligent Capture Module

- Sources:
  - Maintenance history (corrective/preventive) • Operational logs (pressure, temperature, vibration) • Human logs and incident reports
  - Energy and water consumption
- Function: Transforms unstructured and structured sources into a database usable by the LLM + ML model.

b. Pattern Analysis and Detection Module

- Algorithms used: •
  - Decision trees + time series models for correlation of faults.
  - RAG (Retrieval-Augmented Generation) to link history of root cause maintenance.
- Function: Detects:

- Recurrence of failures by component and operator
- Repeated bad configurations
- Areas with high consumption of resources without added value

c. IAGen Solution Generation Module

- Based on GPT-4 Turbo + previous case base + technical standards
- Function:
  - Suggests specific preventive interventions
  - Recommends operational redesigns (e.g.: washing frequency, type of valve, alternative supplier)
  - Generates suggested documentation: improved manuals, operational alerts, action protocols
- Example:
  - "We detected that failures in model X valves increase with temperature above 75 °C. We recommend preventive change to Model Y and redesign of the maintenance plan every 480 hours."

d. Adaptive Feedback Module

- Function:
  - Integrates feedback from operators, engineers and supervisors.
  - Classify the success or failure of the implemented solutions.
  - Adjusts internal models based on observed impact.

e. Communication and Reporting Module

- Function:
  - Explains recommendations clearly according to the user profile (operator, supervisor, manager).
  - Shows expected impact: energy savings, reduction of failures, lower water use, etc.
  - Integrate into dashboards or internal chatbots.

Hypothetical example

Case: Hydraulic Fracturing Plant - Predicting Failures in Critical Valves

- The agent is trained with 5 years of maintenance data.
- Three failure patterns are identified linked to the combination of high pressure, temperature and time between inspections.
- The agent generates alerts for 6 specific valves.
- 4 critical potential failures are anticipated.
- Results:
    - 25% reduction in unplanned failures.
    - Savings of 11 days/year of plant downtime.
    - 15% reduction in water consumption due to adjustments in pressure pumping.

V. Benefits

The application of IAGEN in Continuous Improvement generates significant benefits both to operational and strategic level:

- Efficiency: Reduces analysis and decision-making times, allowing for a faster response to problems and opportunities.
- Cost reduction: Identify opportunities for saving on inputs, maintenance and process optimization.
- Safety: Contributes to the prevention of failures and incidents through predictions based on historical data and risk analysis. AI's ability to Anticipating risks and recommending preventive actions is vital to maintaining a safe working conditions and protect the environment.
- Continuous improvement: Facilitates the identification of areas of opportunity and the implementation of innovative solutions.

VI. Impact and Advantages

IAGEN has a measurable impact on the efficiency and profitability of operations

in Vaca Muerta.

- Production optimization: An increase of 15% in efficiency is estimated in the use of resources, such as water, energy and materials, thanks to the optimization of the drilling and extraction processes. This estimate is based on studies of cases and projections of the sector.
- Failure reduction: IAGEN can contribute to a 30% reduction in operational incidents by predicting failures and implementing preventive measures. This estimate is based on data from companies that have implemented IAGEN solutions in its operations.
- Cost savings: A 10% savings in maintenance costs is projected preventive thanks to the early identification of possible problems and the optimization of maintenance tasks. This projection is based on models IAGEN's cost-benefit analysis of predictive maintenance.

VII. Challenges and Strategies

While IAGEN offers great potential, its implementation in the oil industry is not without challenges.

1. Barriers to Implementation

- Cultural: There may be resistance to change on the part of the operators, who They might perceive IAGEN as a threat to their jobs or distrust of their capabilities.
- Techniques: Integrating IAGEN with existing data systems can be complex and require investment in infrastructure and development.
- Regulatory: It is essential to ensure that the implementation of IAGEN complies with the environmental and safety regulations in force in the oil industry.

To overcome these barriers, a strategic approach that addresses the challenges ahead.

2. Recommended Strategies

To overcome these barriers, it is recommended to implement the following strategies:

- Training and awareness: It is crucial to implement training programs for operators, explaining the benefits of IAGEN, its operation and how it integrates into your daily tasks.
- Integration with existing infrastructure: APIs and connectors should be used to facilitate the integration of IAGEN with existing data systems, minimizing interruptions and maximizing efficiency.
- Short-term investment in AI agent implementation teams Technology and training: Investment in proof of concept and testing is required pilot. The focus here has to be on training the talent to implement, since There is a trend towards cost reduction in systems that allow "no code" and "low code" automation. For the first stage, we also recommends using teams with experience in design and implementation AI agents. Finally, it is key to form an in-house team for the accompaniment and appropriation of an agentic culture that redefines the human-computer interaction.
- Pilots and controlled tests: Gradual implementations are recommended. in specific areas to assess the impact of IAGEN and adjust systems before a large-scale implementation.

VIII. Conclusions

Generative Artificial Intelligence is positioned as a key tool for Promote continuous improvement in the Vaca Muerta oil industry. Its capacity to analyze data, identify patterns and generate customized solutions allows optimize production, reduce costs and strengthen operational safety.

The strategic implementation of IAGEN, accompanied by adequate management of the change and integration with existing systems can generate benefits

significant for the oil industry in Argentina, contributing to a greater efficiency, profitability and sustainability. It is important to highlight the need for a Continuous monitoring and adaptation of IAGEN systems to ensure their effectiveness in the long term.

Furthermore, IAGEN has the potential to contribute to the long-term sustainability of the oil and gas industry in Vaca Muerta.

Early adoption of IAGEN can provide oil and gas companies with Vaca Muerta gas a more competitive advantage in the market.

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