HUB TECH IA

Deliverable report 28

AI and IAGEN Application Use Case

Distribution Optimization in Vaca Muerta: Process Design Based on Data

I. Introduction

Optimizing distribution in Vaca Muerta is crucial for long-term success. from the deposit. Transportation costs are significantly higher in compared to other deposits in countries with better infrastructure, which reduces the competitiveness of Vaca Muerta. The lack of adequate infrastructure increases the vehicle maintenance costs and impacts travel times.

II. Technologies and Tools Available for Distribution Optimization

Optimizing distribution in Vaca Muerta requires the implementation of technologies and tools that enable data analysis and decision making in real time. Below is a table summarizing some of the key technologies:

Technology	Description	Benefits
Management Systems Transport (TMS)	They allow plan, run and optimize the transport of hydrocarbons,	Cost reduction transportation, improvement in the efficiency of the deliveries, elderly

	including management of fleets, tracking shipments and optimization of routes.	chain visibility of supply.
Management Systems Warehouses (WMS)	They optimize the management of inventories, the storage of materials and the order preparation.	Greater efficiency in the logistics operations, error reduction, better control of inventory.
Internet of Things (IoT)	Sensors and devices IoT allow the real-time monitoring real conditions of transport and storage, the location of the vehicles and the state of the teams.	Information in time real for a better decision making, elderly control and efficiency in the operations.
Big Data and Analytics Advanced	The analysis of large data volumes allows identify patterns, predict the demand and optimize the operations.	Better take of decisions, optimization of resources, prediction of the demand.
Artificial Intelligence (AI)	AI algorithms can	Automation of

and Machine Learning	be used for the route optimization, the prediction of the demand, he maintenance predictive equipment and the detection of anomalies in the operations.	tasks, analysis predictive, improvement in the efficiency and safety.
Blockchain	The technology blockchain can improve traceability and transparency in the supply chain.	Greater security and trust in the chain of supply, traceability of products.
Solutions WMS cloud-based	They allow access to the latest updates and innovations, improve cybersecurity and data protection, and guarantee the time of activity.	Elderly efficiency, security and flexibility in the management of warehouses.

III. Application of AI-based agents powered by IAGEN

1. Concept of generative AI

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.

2. **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 objectives in steps, coordinate multiple actions, interact with digital systems (such as databases, APIs or documents) and adapt to context changes in real time. These qualities distinguish them from traditional chatbots, and open 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.

3. IAGen Agentic Flow Design Proposal for Optimization of the Distribution in Vaca Muerta

a. Objective:

Optimize the distribution logistics (mainly land transport) of oil and gas to and from the extraction, storage and refining points, minimizing costs, times and risks, in a complex and highly variable geographical environment

like Vaca Muerta.

b. Description

Phase 1: Data Capture, Integration and Analysis

- Intelligent Monitoring Agent

• Function: Collects data from IoT sensors, truck telemetry, GPS, status of routes, weather, satellite data and external sources (Districts, SMN, Roads).

• Tickets:

• Position and status of each logistics unit

• Loading temperature (gas, oil)

• Road conditions (snow, mud, road cuts)

• Inventory levels and projected demand

• Early warning capability: identifies roadblocks, hazardous conditions adverse weather conditions or operational diversions.

- Operational Data Analyzer Agent

• Function: Use GPT-4 + statistical tools to:

• Detect anomalies on frequent routes

• Predict logistics bottlenecks

• Correlate travel times with external variables

• Results: Generates instant reports in natural language for policymakers decision and feeds the generative agent.

Phase 2: Route Generation, Optimization and Validation

- Route Generative Agent

• Function: Uses LLMs (GPT-4 Turbo with RAG) and optimization algorithms (type TSP with real restrictions) for:

• Simulate optimal routes considering:

ÿ Dangerous cargo

ÿ Routes enabled for heavy vehicles

ÿ Energy consumption and emissions

ÿ Logistics costs by vehicle type and distance

• Incorporate prediction of future demand by area

- Security and Viability Validation Agent

• Function: Evaluates risks associated with each route (product loss, operating conditions, climatic, dangerous or restricted areas).

• Specific tasks:

• Cross-validation with incident history

• Verification of regulatory compliance (weight, type of load)

• Approval or rejection with automated justification

Phase 3: Execution, Adaptive Monitoring, and Learning

- Logistics Executing Agent •

Function: Integrates with the TMS (Transport Management System) or ERP.

• Send instructions to drivers

• Updates the system with estimated schedules

• Generates digital transportation and security documents

• Optional: connection with autonomous or semi-autonomous fleet.

- Adaptive Supervisory Agent

• Function: Monitors in real time and makes decisions in the event of deviations or emergencies or new orders.

• Capabilities:

• Immediate route replanning in the event of events (rain, accidents) • Dynamic fleet reassignment

• Automated communication with human operators

- Learning and Continuous Improvement Agent

• Function: At the end of each logistics operation:

• Evaluate performance

• Learn patterns of failures or delays • Feedback to the system with improvements (fine-tuning, reinforcement)

• Example: if it detects that a validated route always generates delays, it penalizes it in future simulations.

c. Integration with Strategic Indicators (KPI)

All agents are connected to a strategic panel that reports in real time:

- Logistics costs per route
- Average journey time
- COÿ emissions
- Incidents avoided by replanning
- % compliance with logistics SLAs

IV. Specific Challenges of Distribution in Vaca Muerta

Distribution in Vaca Muerta faces specific challenges that must be addressed.
to ensure the efficiency and profitability of operations. Some of the challenges
most important are:

- Infrastructure: The lack of adequate road and rail infrastructure increases the transportation costs, limits the basin's evacuation capacity [1] and increases the risk of accidents.
- Logistics: The complexity of logistics in Vaca Muerta is due to the need to transport large volumes of water, sand and other inputs, as well as the management of waste generated by the activity. In addition, hydraulic fracturing requires the use of fresh water and chemical additives that can have an impact significant environmental.
- Weather Conditions: Adverse weather conditions, such as strong winds, winds and snowfall can affect distribution and cause delays in operations.
- Environment: The activity in Vaca Muerta generates an environmental impact that must be managed responsibly, including air pollution, water use and waste generation. Fracking, in particular, uses a variety of chemicals, some of which are suspected of causing cancer and other health damage.

- Labor: The lack of skilled labor in the region increases costs
  labor and may cause delays in operations.

V. Solutions and Recommendations to Improve Distribution

To improve the efficiency and profitability of distribution in Vaca Muerta,
propose the following solutions and recommendations:

- Implementation of Technologies: The adoption of technologies such as TMS, WMS, IoT,
  Big Data and AI can optimize operations, improve decision making and
  reduce costs.
- 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.
- Logistics Planning: Efficient logistics planning that considers the
  climatic conditions, resource availability and risk management is
  essential to avoid delays and optimize operations.
- Environmental Management: Implement measures to minimize the environmental impact of
  the activity, such as wastewater treatment, waste management and
  use of cleaner technologies.
- Staff Training: Invest in the training of local staff to
  ensure the availability of skilled labor and reduce dependence on
  workers from other areas.
- Public-Private Collaboration: Promote collaboration between the public and private sectors.
  private sector for infrastructure development, technology implementation and

staff training. An example of this is the Gas Pipeline declaration Perito Moreno as a project of national interest by the government, which facilitates investment and development of key infrastructure.

VI. Data Visualization for Distribution Optimization

Data visualization plays a crucial role in optimizing distribution in Vaca Muerta. Maps and visualizations are used to represent information. relevant to the formation, such as thickness maps, organic content maps total (TOC) and paleogeographic maps. These maps help to understand the distribution of resources, identify areas of greatest potential and optimize the drilling and production planning.

VII. Conclusions

Optimizing distribution in Vaca Muerta is a key factor for success. long-term of the deposit. The implementation of data-driven processes, the Investment in infrastructure and the adoption of new technologies are essential for improve the efficiency, profitability and sustainability of operations. Address the region-specific challenges such as logistics, weather conditions and environmental impact, requires strategic planning and collaboration between different actors involved.

To achieve effective distribution optimization, it is necessary to:

- Improve road and rail infrastructure: Reduce transportation costs, increase evacuation capacity and minimize the risk of accidents.
- Implement information technologies: Optimize operations, improve decision-making and facilitate supply chain management.
- Strengthen logistics planning: Consider critical variables, such as weather conditions and risk management, to avoid delays and optimize the operations.

- Prioritize environmental management: Minimize the impact of the activity on the environment environment, including responsible water use and waste management.
- Invest in staff training: Ensure the availability of labor qualified and reduce dependence on external workers.
- Promote public-private collaboration: Facilitate investment in infrastructure, the implementation of technologies and the development of the region.

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