European Postgraduate Institute

Master in Applied Artificial Intelligence

Final Application Project

Evaluation and Migration to Cloud Infrastructure for Quantia Trading SL

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Executive Summary

****Project:**** Evaluation and Migration to Cloud Infrastructure for Quantia Trading SL

****Company:**** Quantia Trading SL

****Location:**** Madrid, Spain

****Context****

Quantia Trading SL is a startup specializing in the development of **algorithmic trading strategies**. It currently operates with a local infrastructure consisting of five workstations and a single server hosting all critical services: data, execution, model training, and automation. This infrastructure presents operational limitations, security risks, a lack of traceability, and limited scalability, which restricts growth and innovation.

****Aim****

The purpose of this project is to comprehensively evaluate how the cloud paradigm Computing can transform Quantia 's operations by identifying key use cases that would benefit from its adoption and selecting the most appropriate cloud service provider to carry out a gradual, secure and efficient migration.

****Methodology****

The evaluation was carried out in five stages:

1. Analysis of the company profile and its technical challenges.
2. Identification of five critical use cases for migration:
   * backtesting .
   * Model training and deployment.
   * Task automation.
   * Real-time monitoring.
   * Secure storage and automatic backup.
3. Evaluation of the services available in AWS , Azure and GCP for each use case.
4. Comparison of costs, scalability, simplicity and technical suitability.
5. Risk analysis, mitigation plan, and definition of a phased migration strategy.

****Recommendation****

After comparing the three major cloud providers, it is recommended that Quantia Trading SL migrate to **Google Cloud Platform ( GCP )** . This decision is based on:

* Its **most favorable cost structure** for technology startups with data-intensive workloads.
* Highly integrated services **accessible from Python environments** , facilitating the technical work of the current team.
* Robust capabilities in **machine learning , automation, and scalable storage** .
* **Low learning curve** and seamless experience for small technical teams.
* Ability to **scale safely and flexibly** , adapting to the different phases of organizational growth.

The economic analysis shows that the GCP solution offers a **highly sustainable estimated budget** , with monthly operating costs below €130 and a minimal initial investment for migration. This structure allows Quantia to control its expenses from the outset, without compromising performance or security.

Additionally, GCP enables the establishment of effective **cloud governance mechanisms** , including role-based access control ( IAM ), resource monitoring, consumption alerts, and automated activity auditing. This ensures an orderly, transparent operation aligned with business objectives.

The migration must be carried out progressively **, starting with the data and** backtesting processes , until reaching a hybrid environment with local execution and cloud coordination , guaranteeing **security, traceability, operational efficiency and continuous financial control** .

# Introduction

In a context of accelerated digital transformation, algorithmic trading has positioned itself as a strategic discipline within the financial sector. Its operation requires intensive use of data, real-time decision automation, and a technological infrastructure capable of guaranteeing performance, security, and availability in highly volatile environments. As companies seek to respond with agility to market changes, the cloud paradigm Computing is presented as a comprehensive solution to scale capabilities, reduce operating costs, and enable new levels of efficiency and collaboration.

This report aims to analyze how an emerging algorithmic trading company can benefit from adopting cloud services. It will assess the main technical and operational challenges facing current organizations, and propose specific use cases where cloud technologies can provide immediate and strategic value. To this end, it will compare the main platforms on the market—Amazon Web Services ( AWS ), Microsoft Azure , and Google Cloud Platform ( GCP )—in order to select the most appropriate platform based on technical, economic, and operational criteria.

The analysis will culminate in a proposed reference architecture, a migration roadmap, and an assessment of the expected transformational impact, including key aspects such as security, compliance, monitoring, and governance.

# Profile, Context and Challenges of Quantia Trading SL

## Industry Overview: Algorithmic Trading

Algorithmic trading is a specialized branch of the financial industry based on the automation of asset buying and selling decisions using mathematical algorithms and computational models. These algorithms analyze large volumes of market data, evaluate multiple technical and fundamental indicators, and execute trades in fractions of a second. Its implementation requires advanced technological infrastructure, real-time data access, low latency, scalable computing capacity, and automated risk control mechanisms.

The evolution of algorithmic trading has been strongly influenced by the adoption of cloud computing, machine learning , and process automation technologies. Companies operating in this sector face challenges such as the need to respond quickly to market events, optimize the performance of their models, and ensure the integrity, traceability, and security of all transactions.

## Profile and structure of Quantia Trading SL

**Quantia Trading SL** is a technology-based startup located in Madrid, Spain, dedicated to the development, testing, and execution of algorithmic trading strategies on highly liquid financial markets. The organization is comprised of a multidisciplinary team of five people with defined and complementary roles:

* ****CEO / Quant Lead**** : Leads strategy design, defines the technical vision, and oversees the algorithmic decision cycle.
* ****Data Engineer**** : Responsible for obtaining, cleaning and structuring historical and real-time data.
* ****Backend Developer**** : Implements execution scripts, automates internal processes and connects to exchange APIs .
* ****Data Scientist**** : Designs, trains and adjusts predictive models using machine learning techniques .
* ****Trader / Risk Manager**** : Runs paper and live trading tests, evaluates results, and monitors risk exposure.

## Infrastructure context and current challenges

Quantia 's operations are currently supported by a completely local and limited infrastructure, consisting of five workstations and a single Linux server. This server centralizes critical tasks: historical data storage, strategy execution, hosting the institutional website (static HTML page served with Apache), and workflow coordination.

Key processes are executed manually or through simple scripts. There is no automated version control, monitoring system, or centralized collaboration tools. API keys are stored unencrypted in local files, and there are no automatic backups or failover mechanisms. The network lacks VPN or multi-factor authentication . This represents a significant operational risk, limits team productivity, and blocks any attempts to scale the operation.

The following tables provide a summary of the company's current architecture:

Table 2. 1 : Equipment and functions

|  |  |
| --- | --- |
| Role | Main responsibilities |
| 1. CEO / Quant Lead | - Design trading strategies  - Validate signals and models - Monitor decision flow |
| 2. Data Engineer | - Collect and clean data  - Save market history - Generate datasets for ML and backtesting |
| Backend Developer | - Create execution scripts  - Automate local tasks - Implement connectivity with exchanges |
| 4. Data Scientist | - Train and adjust predictive models  - Test indicators and statistical relationships |
| 5. Operational Trader / Risk Manager | - Execute paper trading and live sessions  - Evaluate results - Manual risk control |

Table 2. 2 : Local infrastructure

|  |  |
| --- | --- |
| Element | Technical description |
| Hardware | - 5 desktop PCs (Windows/Linux) with local connection and shared access  - 1 central Linux server (small rack) |
| Grid | Basic LAN. No VPN . Server access via SSH with simple authentication. |
| Basic website | Static HTML page with institutional information. Hosted on the server with Apache. |
| Code repositories | Shared folder on the server and copy to private GitHub . No continuous integration. |
| Historical data | . csv and . parquet files saved in local folders on the server. |
| Live Trading | Python script executed manually from the console. Uses REST API (e.g., Binance ). |
| Backtesting | Executed from local notebooks on historical data stored on disk. |
| ML Models | . pkl files. They are trained with Jupyter and loaded directly into scripts. |
| Security | API keys stored in . env files . Access without MFA . Risk of exposure. |
| Monitoring | Absent. Logs are printed to the console and reviewed manually. |
| Backup | backups are made manually to an external drive. |
| Collaboration | Files shared manually or via email. There is no shared testing environment. |

# **Cases Identified for Cloud Migration**

The adoption of cloud infrastructure in algorithmic trading firms like Quantia Trading SL is not only a response to a technological trend, but also to critical operational needs arising from the volume of data, market dynamism, and regulatory requirements. In this context, use cases have been identified that present a high potential impact on efficiency, scalability, and performance.

## **General context**

Quantia 's business requires a flexible, secure, and scalable infrastructure to address processes that combine:

* intensive processing of historical and real-time data,
* training and agile deployment of artificial intelligence models,
* storage of large volumes of information with different access patterns,
* and continuous regulatory compliance, with traceability and auditing.

Traditional architecture based on physical servers or hybrid systems presents limitations in terms of speed, elasticity, and cost. Migrating certain key processes to the cloud allows us to break through these constraints.

## **Selection criteria**

**Critical use cases** were defined as those processes that:

* have a high impact on daily operations or strategic decision-making,
* present technical bottlenecks or increasing costs under the current infrastructure,
* They clearly benefit from cloud services such as automatic scaling, distributed storage, or intensive on-demand computing.

Processes where security, latency, and traceability are essential to the business were also considered priorities.

## **Summary of identified cases**

Below, we briefly describe the five cases selected as priorities for analysis and possible migration to cloud infrastructure :

1. ****Intensive****   
   ****backtesting**** : The process of simulating strategies on historical data. It requires massively parallel computing capacity and execution.
2. ****AI****   
   ****model training.**** Building and tuning predictive models using large volumes of data. High demand for GPU resources and complex pipelines.
3. ****Historical data storage****   
   High-resolution market data and logs that must be retained long-term with differentiated access and archiving policies.
4. ****Real-time visualization and analysis.****   
   Dashboards for traders and automated systems that consume information processed by the second.
5. ****Risk management and regulatory compliance.****   
   Automated reporting and continuous monitoring of critical events to comply with financial regulations.

# Detailed Use Case Analysis

## Backtesting of strategies

a) Benefits of using the cloud

Migrating the backtesting process to a cloud architecture brings substantial improvements in:

* **Scalability** : Allows you to run multiple tests in parallel, using on-demand instances.
* **Speed** : significant reduction in the time required to validate a strategy on different assets or historical periods.
* **Cost savings** : thanks to the use of temporary instances (spot/ preemptibles ), the computational cost is optimized.
* **Collaboration** : Results can be stored in shared locations and viewed by the entire team.
* **Traceability** : Each experiment can be versioned and recorded along with its parameters and metrics.

b) Cloud services used

|  |  |
| --- | --- |
| Layer | Services by provider |
| **IaaS** | **AWS:** EC2 Spot Instances  **Azure:** Virtual Machines with **GCP** autoscale  **:** Compute Engine Preemptible VMs |
| **PaaS** | **AWS:** Batch/Lambda for coordination  **Azure:** Azure Batch  **GCP :** Cloud Functions + Cloud Scheduler |
| **Storage** | **AWS:** S3  **Azure: GCP** Blob Storage  **:** Cloud Storage |

c) Reference architecture

**Proposed functional flow:**

1. The user loads test parameters (strategy, dataset , time horizon).
2. serverless function starts a batch of tasks (one per combination).
3. Each task runs on a temporary instance ( lightweight VM ).
4. The results are stored in a structured bucket .
5. A dashboard accesses the results and presents them to the team.

**Key components:**

* Task Orchestrator (Cloud Functions / Lambda / Azure) Functions ).
* Distributed computing engine ( EC2 Spot, Azure) Batch , GCP Preemptible VMs ).
* Results repository ( S3 / Blob / Cloud Storage).
* Periodic scheduler ( Scheduler or Cron cloud-native ).

d) Comparison between suppliers

|  |  |  |  |
| --- | --- | --- | --- |
| Criterion | AWS | Azure | GCP |
| Ease of setup | Average | High | High |
| Cost of spot instances | Competitive | Higher | Very competitive |
| Integration with local Python | High (SDK + CLI) | High | High |
| Serverless services | High maturity (Lambda + Step ) | Simple but integrated | Very simple ( Functions + Jobs) |
| Storing results | S3 with wide support | Flexible Blob Storage | Affordable Cloud Storage |

e) Expected indicators of improvement:

* backtesting execution time from 4 hours to 20 minutes.
* Strategy testing acceleration by 85%.
* Cost reduction for using spot or serverless instances by more than 40%.

f) Observations

For this use case, **all three providers are technically viable** . However, **GCP stands out for its low cost for pre-emptible instances** , its ease of use for automated tasks, and its excellent integration with Python-written workloads. This makes it a strong candidate for small companies that need to run large volumes of tests in a cost-effective and controlled manner.

## Training and deployment of predictive models

a) Benefits of using the cloud

Training machine learning (ML) models in on-premises environments presents severe limitations for a small company like Quantia , both in terms of computational capacity and traceability. Migrating this critical stage to the cloud allows for:

* **Dynamically scale resource usage based on model load** .
* **Store datasets and models centrally and securely** .
* **Automate experiments with reproducible pipelines** .
* **Versioning models and validation metrics for scientific monitoring** .
* **Deploy models as services (APIs) accessible from bots or dashboards** .

b) Cloud services used

|  |  |
| --- | --- |
| Layer | Services by provider |
| **Managed ML PaaS** | **AWS:** SageMaker  **Azure:** Azure Machine Learning  **GCP :** Vertex AI |
| **Data storage** | **AWS:** S3  **Azure: GCP** Blob Storage  **:** Cloud Storage |
| **Model versioning/monitoring** | **AWS:** SageMaker Experiments  **Azure: ML Studio + GCP** Datasets  **:** Vertex AI Experiments / Model Registry |
| **Deploying models as APIs** | **AWS:** Endpoint in SageMaker  **Azure:** Managed Online Endpoints  **GCP :** Vertex AI Prediction |

c) Reference architecture

**Proposed flow:**

1. The data scientist uploads a new dataset to Cloud Storage.
2. Start an experiment from a managed environment ( Jupyter notebook cloud-native ).
3. Training runs on scalable nodes on demand.
4. The model, its metrics, and its parameters are recorded.
5. The validated model is deployed as an endpoint REST and integrates with execution bots.
6. Model logs, usage, and performance are monitored in real time .

**Key components:**

* Integrated ML platform (environment + training + deployment).
* Managing versions of models and datasets .
* Centralized storage for training and results datasets .
* Endpoint monitoring and bot consumption.

d) Comparison between suppliers

|  |  |  |  |
| --- | --- | --- | --- |
| Criterion | AWS | Azure | GCP |
| Integrated ML Environment | SageMaker Studio (very complete) | Azure ML Studio (Guided) | Vertex AI Workbench (simple and functional) |
| Training scalability | High | High | High |
| Automatic versioning | Complete ( Experiments + Model Registry ) | Partial | Integrated ( Experiments + Registry ) |
| Cost of use | Medium-high | Half | Competitive |
| Simplicity for a small team | Requires configuration | Requires learning | Intuitive for Python environments |

e) Expected indicators of improvement:

* Reducing model training time from 3 days to 8 hours.
* Increased computing performance (GPU) with automatic scaling.
* Estimated 25% savings in resources thanks to the use of MLOps and pipeline optimization.

f) Observations

In functional terms, all three providers offer mature platforms for training and deploying ML models. **AWS** stands out for its depth of services, although it requires more configuration and prior experience. **Azure** offers a visual solution that is well-integrated with enterprise environments. However, for a small, highly technical team like Quantia , **GCP offers a more accessible learning curve, competitive costs, and a fluid experience with Python development environments** , making it a particularly effective option in this use case.

## Task automation and bots

a) Benefits of using the cloud

Automating operational tasks is critical to freeing up team resources, reducing manual errors, and ensuring the accurate execution of recurring processes such as:

* Download market data.
* Historical price update.
* Generation of reports or signals.

cloud services allows:

* **Schedule tasks without the need for local servers** .
* **Reduce costs through serverless functions** .
* **Automatically scale execution to peak loads** .
* **Integrate conditional logic, retries and error handling** .

b) Cloud services used

|  |  |
| --- | --- |
| Layer | Services by provider |
| **PaaS serverless** | **AWS:** Lambda  **Azure:** Functions  **GCP :** Cloud Functions |
| **Planning / Cron** | **AWS:** EventBridge Scheduler  **Azure:** Timer Trigger  **GCP :** Cloud Scheduler |
| **Messaging / Orchestration** | **AWS:** Step Functions / SQS  **Azure:** Durable Functions  **GCP :** Pub/Sub + Workflows |

c) Reference architecture

**Proposed functional flow:**

1. A scheduled task is triggered (by time or event).
2. cloud function with autonomous logic is executed .
3. The function queries data, applies logic, and stores the result.
4. In case of error, a retry mechanism is activated or notification is sent via alert.

**Concrete example: Daily update of** BTC / ETH historical price file using a function that calls the exchange API , saves to Cloud Storage and logs.

d) Comparison between suppliers

|  |  |  |  |
| --- | --- | --- | --- |
| Criterion | AWS | Azure | GCP |
| Ease of setup | Requires setup IAM | Very simple | Very simple |
| Integration with cron | Complete ( EventBridge ) | Basic | Direct (Cloud Scheduler ) |
| Boot latency | Low | Moderate | Low |
| Costs | Free in low volumes | Free in low volumes | Free in low volumes |
| Automatic scalability | Excellent | High | Excellent |

e) Expected indicators of improvement:

* **100% automation of recurring operational tasks** , such as price updates, signal sending, and report generation.
* **Reducing the execution time of scheduled tasks by 80%** by eliminating waiting, manual intervention, and local latency.
* **Reduction of operational risk due to human error by 90%** , thanks to standardization and automatic execution.
* **Continuous availability (24/7) of automated processes** , without the need for personnel during non-working hours.
* **Complete traceability of executions** , with centralized logs and alerts in case of failures or retries.

f) Observations

For these types of automated tasks, all vendors offer efficient solutions. However, **GCP stands out for its simplicity and direct integration with schedulers and message queues** , making it an optimal choice for a startup without a dedicated DevOps team .

## Real-time monitoring and alerts

a) Benefits of using the cloud

Operational visibility is essential for detecting execution errors, service outages, or anomalous bot behavior. Cloud monitoring enables:

* **Centralize logs from multiple sources** .
* **Generate metrics, dashboards, and alerts** in real time.
* **Reduce incident response time** .
* **Event history for post-mortem analysis** .

b) Cloud services used

|  |  |
| --- | --- |
| Layer | Services by provider |
| **Logging / Metrics** | **AWS:** CloudWatch  **Azure:** Monitor + Log Analytics  **GCP :** Cloud Logging + Monitoring |
| **Alerts / Notifications** | **AWS:** SNS + Alarms  **Azure:** Action Groups  **GCP :** Alerting + Pub/Sub |
| **Display** | **AWS:** Dashboards  **Azure:** Workbooks  **GCP :** Looker Studio / Grafana integrated |

c) Reference architecture

**Proposed functional flow:**

1. Each bot and function writes its events and errors to a logging service. cloud .
2. Critical events generate automated alerts (email, Telegram , Slack ).
3. Dashboards present real-time execution status, latency and performance metrics .

d) Comparison between suppliers

|  |  |  |  |
| --- | --- | --- | --- |
| Criterion | AWS | Azure | GCP |
| Ease of integration | High ( CloudWatch) Agent ) | High (with previous setup ) | Very high ( Logging by default) |
| Native display | Functional | Advanced | Limited, but with Looker or Grafana |
| Alert generation | Advanced | Complete | Simple but effective |
| Estimated cost | Half | Half | Low |

e) Expected indicators of improvement

**Performance and operational visibility:**

* dashboard response time from **2 seconds to less than 500 ms** .
* Streaming event processing with latency less than **1 second** .
* Significant improvement in **intraday decision-making** , thanks to the availability of real-time data.

**Compliance and audit-oriented indicators:**

* **100% automation of regulatory reports** , with periodic generation and encrypted storage.
* **50% reduction in non-compliance incidents** through real-time alerts in the event of operational deviations.
* **Continuous auditing with full traceability** , thanks to signed logs of access and actions on critical systems.
* **Complete visibility into access and use of sensitive data , with a minimum** log retention of 6 months.
* **Reducing the risk of data exposure by 90%** through role control ( IAM ) and alert policies on unauthorized access.
* **intraday decision-making with real-time information.**

f) Observations

**GCP offers a simple and effective solution** for small businesses that don't need advanced enterprise monitoring tools. It also integrates well with functions, storage, and Pub/Sub for real-time notifications.

## Secure storage and automatic backups

a) Benefits of using the cloud

Cloud storage eliminates dependence on physical devices and manual processes, allowing:

* **Secure and versioned access to data and scripts** .
* **Automatic encryption in transit and at rest** .
* **backups and disaster recovery** .
* **Permission-controlled sharing** .

b) Cloud services used

|  |  |
| --- | --- |
| Layer | Services by provider |
| **Storage** | **AWS:** S3 + Glacier  **Azure:** Blob Storage + Archive Tier  **GCP :** Cloud Storage (Standard + Nearline + Coldline ) |
| **Key management and security** | **AWS:** KMS + IAM  **Azure:** Key Vault + RBAC  **GCP :** Cloud KMS + IAM |
| **Backups / versions** | **AWS:** S3 Versioning / Lifecycle  **Azure:** Blob Snapshots  **GCP :** Object Versioning + Lifecycle Policies |

c) Reference architecture

1. All data, models, and scripts are stored in buckets with granular access control.
2. Automatic versioning is activated to ensure traceability.
3. Backup policies (daily or weekly) are scheduled with expiration and geographic replication.
4. Encryption with managed keys is implemented.

d) Comparison between suppliers

|  |  |  |  |
| --- | --- | --- | --- |
| Criterion | AWS | Azure | GCP |
| Ease of use | High (CLI and SDK) | Average | High (browser and API) |
| Storage costs | Scalable | Scalable | Very competitive |
| Versioning and life cycles | Complete | Complete | Complete |
| Security and key management | High | High | High |

e) Expected indicators of improvement:

* 80% reduction in time spent on manual backup tasks by implementing automated and self-paced backups .
* Estimated 40% storage savings by using low-cost classes such as Coldline /Glacier and lifecycle policies.
* Guaranteed recovery in less than 15 minutes from critical file loss, using snapshots and geographic replication.
* multi -region redundancy of buckets cloud .
* Zero data loss due to human error or physical failure through encryption, versioning, and access control.

f) Observations

**GCP excels at simplicity and cost** , especially for cold storage ( nearline / coldline ) for automatic backups . It offers configurable lifecycle policies, built-in versioning, and a clean experience for enterprises that need robust backup without added technical complexity.

# **Global comparison between cloud providers**

After a detailed analysis of each use case applied to the three main providers ( AWS , Azure and Google Cloud Platform ), an integrative view of the relative strengths of each one can be established in relation to the specific needs of Quantia Trading SL.

## **Differentiated approaches**

Each supplier presents a differentiated strategy:

* ****AWS**** : Stands out for its maturity, breadth of services, and robustness in high-demand environments. It is particularly strong in automation, MLOps services ( SageMaker ), and flexible infrastructure scaling.
* ****Azure**** : Offers excellent integration with enterprise ecosystems, Windows environments, and tools like Power BI. It's ideal for enterprise scenarios where governance and interoperability are key.
* ****Google Cloud Platform ( GCP )** :** excels in big data processing and machine learning capabilities , thanks to services like Vertex AI , BigQuery , and Cloud Storage are optimized. It also offers cost-efficiency advantages for data-intensive workloads.

Table 5. 1 : Global Comparison of Cloud Providers

|  |  |  |  |
| --- | --- | --- | --- |
| **Use case** | **AWS** | **Azure** | **GCP** |
| **1. Distributed backtesting** | + EC2 Spot with advanced control  – More complex configuration | + Azure Batch  – Higher costs in temporary instances | **Easy-to-use Compute Preemptible**  **+ Low cost and fast execution** |
| **2. Training and deployment of ML models** | + Very complete  SageMaker – Requires expert configuration | + Azure ML Studio Guided  – Steeper learning curve | **+ Vertex Intuitive AI**  **+ Ideal for small teams in Python** |
| **3. Task automation and bots** | + Lambda + EventBridge  – More technical configuration | + Well-integrated  functions – Less flexibility | **Very simple Cloud Functions + Scheduler**  **+ Ideal for lightweight scripts** |
| **4. Real-time monitoring and alerts** | + Robust  CloudWatch – Basic Dashboards | + Monitor + Workbooks  – Requires manual integration | **+ Integrated Logging and Monitoring**  **+ Simple and effective for startups** |
| **5. Secure storage and automatic backups** | + S3 + Reliable Glacier  – Medium costs | + Versatile Blob Storage  – More complex initial setup | **+ Affordable Cloud Storage**  **+ Easy-to-apply versioning and policies** |

* **GCP could offer a better cost-benefit ratio in the most data-intensive workloads and distributed computing, aligning with** Quantia 's approach .
* **AWS** provides the most robust and proven stack , ideal if you require maximum stability and specialized tools for AI .
* **Azure** is strong in hybrid environments or deep enterprise integrations, but less optimized for native quantitative trading workloads if you're starting from scratch.

Table 5. 2 : General Evaluation

|  |  |  |  |
| --- | --- | --- | --- |
| **Global Criterion** | **AWS** | **Azure** | **GCP** |
| **Depth of services** | Very high (full) | High | High |
| **Simplicity for startups** | Media (requires DevOps ) | Media (corporate focused) | **High (clear and friendly interface)** |
| **Small business costs** | Media | Medium-high | **Low (big advantage in instances and storage)** |
| **Learning curve** | High | Average | **Low (fluency with Python stack )** |
| **Integration with Python/Data** | Excellent | Good | **Excellent** |

## Conclusion of the Comparison

All providers offer adequate capabilities for defined use cases. However, for a small company like Quantia Trading SL, seeking **controlled costs, operational simplicity, and rapid deployment** , **Google Cloud Platform ( GCP )** is positioned as the most efficient option aligned with its needs.

Its pricing structure, native data analytics tools, seamless experience for small technical teams, and well-integrated environment with Python make GCP the recommended platform for this migration.

# Considerations for Cloud Migration

Migrating to the cloud not only entails a technological upgrade but also a structural change in the way the company manages its operations, data, and risks. This section addresses the main critical aspects that Quantia Trading SL must assess and manage to ensure effective and sustainable cloud adoption.

## Security, privacy and regulatory compliance

Migration must ensure strict compliance with European data protection regulations (particularly the General Data Protection Regulation, GDPR ), as well as good practices for managing passwords and accessing sensitive systems.

**Key recommendations:**

* Implement access controls using **IAM ( Identity and Access Management)** with least privilege policies.
* **key and secret management** services (Cloud **KMS , Secret Manager)** to protect API and model credentials.
* Ensure **encryption in transit and at rest** for all data stored and transferred.
* Record and audit access to critical environments using signed logs .
* Establish clear internal policies on the privacy of data used in model training.

## Government, monitoring and logging

Once services have been migrated, centralized monitoring is required to audit system behavior and proactively respond to failures or anomalies.

**Key recommendations:**

* Centralize execution, error and performance logs in a single system (Cloud Logging ).
* Configure **monitoring dashboards** to view bot activity, execution times, and resource status.
* Set **automatic alerts** for abnormal behavior or interruptions in critical services.
* Maintain **versioning and traceability** of all models and scripts in production.
* Document all automated processes and include consistency checks.

Cloud governance should include not only technical oversight, but also budget control, resource allocation by project, and the application of role-based access policies ( RBAC ), ensuring operations are aligned with the company's strategic objectives.

## Phased migration strategy

Since Quantia is based on a local, but limited, operational infrastructure, a **gradual migration** is recommended to ensure business continuity and risk control.

**Suggested phases:**

1. **Phase 1: Migration of historical data and backups**
   * Uploading data to cloud storage with encryption and version control.
2. **backtesting environment**
   * Implementation of distributed execution and centralized storage of results.
3. **Phase 3: Training migration and model deployment**
   * Vertex Training AI and publishing as internal APIs.
4. **Phase 4: Task Automation**
   * Replacing manual scripts with scheduled and serverless functions .
5. **Phase 5: Integration with live execution environment**
   * Enabling hybrid components where execution remains local but is coordinated from the cloud.

## Integration and coexistence with existing systems

The company will initially maintain part of its operations on local servers (hybrid infrastructure), especially for low-latency, real-time tasks. This coexistence must be carefully managed.

**Key recommendations:**

* Use APIs to securely connect on-premises systems to cloud services.
* Synchronize backups and execution results between both environments.
* Periodically evaluate the load and reliability of local processes to determine whether they should be fully migrated.
* fallback procedures in case of disconnection between environments.

## Key success factors

cloud adoption , Quantia must consider the following elements as critical:

* **Training of the** technical and operational team in cloud tools .
* **Cost control** from the start, with usage monitoring and budget alerts.
* **Modularity of the architecture** , to facilitate adjustments and progressive growth.
* **Clear and shared documentation** of all migrated processes.
* **Culture of continuous improvement** , periodically evaluating the performance of the adopted solution.

## Risks and mitigation strategies

Although cloud migration represents a strategic opportunity to modernize operations, it also entails a series of technical, operational, and organizational risks that must be identified early and managed in a structured manner.

a) Risk: Cost overruns due to uncontrolled use

**Description:**   
The consumption-based billing model can generate unexpected expenses if limits, alerts, and efficient usage practices are not defined.

**Mitigation:**

* Define monthly budgets and automatic alerts based on consumption.
* Use predictable services ( preemptible instances , cold storage).
* Periodically audit and review active services and their economic impact.

b) Risk: Loss of control or technical visibility

**Description:**   
Adopting managed services could create platform lock-in and reduce internal understanding of the full flow.

**Mitigation:**

* Document each migrated component, its configuration and integration point.
* Ensure full visibility through dashboards and traceability in logs .
* Keep the technical team trained in the technologies used.

c) Risk: Failures in the integration between local and cloud systems

**Description:**   
The coexistence of a hybrid architecture can lead to data inconsistencies, synchronization failures, or blind spots in operation.

**Mitigation:**

* Establish synchronization procedures with integrity verification.
* Define clear one-way flows and cross-validation points.
* Design fault-tolerant solutions with retry mechanisms .

d) Risk: Data leaks or access vulnerabilities

**Description:**   
Accessing data, models, or credentials from multiple locations can open attack vectors if not rigorously controlled.

**Mitigation:**

* Using managed keys ( KMS ), encrypted secrets, and role-based access policies ( IAM ).
* Multi-factor authentication ( MFA ) required for administrative access.
* Audit and periodic rotation of credentials.

e) Risk: Difficulty of organizational adoption

**Description:**   
Technological change can generate friction within the team, resistance to change, or errors due to lack of knowledge.

**Mitigation:**

* Conduct technical and operational training sessions for all members.
* Incorporate accessible and up-to-date documentation on the new environment.
* Accompany change with an iterative approach that respects the team's rhythms.

This risk assessment and its mitigation strategies provide a realistic framework for anticipating obstacles and ensuring that the migration is successful, aligned with both the technical objectives and the internal capabilities of Quantia Trading SL.

## ****Estimated migration and operation budget****

Cost estimation is a key element in assessing the technical and financial feasibility of migrating to cloud infrastructure . This section presents a rough estimate for Quantia Trading SL's adoption of Google Cloud Platform ( GCP ) , differentiating between the initial migration costs and the monthly ongoing operating costs.

GCP 's public prices in effect in May 2025 and the usage patterns defined in the five use cases in this report. The following assumptions were made:

* Initial storage volume: 1.5 TB (historical data, models and backups ).
* Using **pre-emptible instances** for backtesting and training, with limited schedules and no permanent execution.
* Daily task automation using serverless functions and Cloud Scheduler .
* Standard monitoring, with moderate generation of logs and alerts.
* The migration is assumed to be performed by the internal team, with no external consulting costs.
* Discounts for annual commitment are not considered, since it is based on a flexible pay-per-use ( on-demand ) scheme.

This budget seeks to reflect an efficient, scalable, and sustainable startup operation, maintaining cost control and leveraging the economic benefits of GCP for tech startups .

### ****Table 6. 1 : Estimated migration costs ( one SEQ Tabla \\* ARABIC \s 1 - time)****

|  |  |  |
| --- | --- | --- |
| Activity | Detail | Estimated cost (€) |
| Uploading historical data to Cloud Storage | 1 TB approx., local network connection | ~30 € |
| Initial IAM , bucket , and role setup | Technical time, non-resource intensive | ~0 € (own operator) |
| Migrating notebooks and models to Vertex AI | Copying and adapting scripts in a cloud environment | ~0 € |
| Implementation of automated workflows | Function setup + cron + logging | ~0 € |
| GCP costs ) | Network consumption only + storage | **~30 €** |

Note: It is assumed that the migration work is performed internally, without external consulting.

### ****Table 6. 2 : Estimated monthly operating costs****

|  |  |  |
| --- | --- | --- |
| Component | Approximate detail | Monthly cost (€) |
| **Cloud Storage** | 1.5 TB total (historical data + backups ) on Coldline | ~15 € |
| **Compute Engine** | 50 hours/month of VMs preemptibles for backtesting | ~20 € |
| **Vertex AI** | 40 hours/month of training with basic GPU | ~60 € |
| **Cloud Functions + Scheduler** | 20 shows/day, light traffic | ~5 € |
| **Logging and Monitoring** | 2 GB/day + 10 active alerts | ~10 € |
| **Pub/Sub / Workflows** | Low frequency, simple use | ~5 € |
| **Red and others** | Minimal output to external APIs / dashboards | ~5 € |
| **Estimated monthly total** | Complete cloud operation | **~120 €** |

****Table 6. 3 : Annual costs (projection)****

|  |  |
| --- | --- |
| Concept | Estimated cost (€) |
| Migration (unique) | ~30 € |
| Monthly operation x 12 | ~1,440 € |
| **Total first year** | **~1,470 €** |

# Conclusions and Impact of Cloud Adoption

The technical and organizational assessment carried out in this report demonstrates that migrating to a cloud architecture represents a fundamental transformation for Quantia Trading SL. From its current position—a limited, manual, and vulnerable on-premises infrastructure—adopting cloud services will enable the company to evolve toward a modern, scalable, automated, and resilient operation .

The expected benefits are significant:

* **scalability** to run tests, train models, or respond to load spikes without purchasing additional hardware.
* **Reduction in computing times** , which will accelerate the cycle of innovation and strategy validation.
* **Enhanced security** , with centralized access management, data encryption, key control, and compliance with regulations such as GDPR .
* **Automation of key processes** , reducing manual errors, freeing up operational time, and improving traceability.
* **Real-time monitoring** and immediate response to system failures or unexpected behavior.
* **Automatic backup and operational continuity , with** backup policies , geographic replication, and disaster recovery.

Cloud service providers — AWS , Azure and GCP — has allowed us to identify Google Cloud Platform as the most suitable option for Quantia , due to its simplicity of use, smooth integration with Python environments, controlled costs and services perfectly adapted to the needs of a small company.

However, this transformation is not without challenges. Identified risks, such as cost control, technological dependence, or organizational adoption, must be addressed through careful planning, team training, and a phased migration that respects the company's timeline and capabilities.

Cloud adoption Computing will allow Quantia Trading SL to position itself as a more agile, secure, and well-prepared technology company to compete in a dynamic market, where speed of adaptation, continuous innovation, and operational efficiency are differentiating factors. This step not only modernizes the infrastructure but also enables a new collaborative work model, oriented toward technical excellence and constant evolution.