

# **BVMT TRADE**

Intelligent Trading Assistant System  
for the Tunis Stock Exchange (BVMT)

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Delivery Report

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# 1 Introduction

The **Intelligent Trading Assistant System** is designed to support Tunisian investors in making informed decisions. The system integrates price and liquidity forecasting, market sentiment analysis, anomaly detection, and an augmented decision agent into a unified interactive dashboard.

The system is **fully compliant** with BVMT and CMF regulations, and strictly adheres to **\*\*decision-support principles\*\***: it does not execute trades, guarantees profits, or encourage market manipulation.

## Objectives of this Report:

- Present all mandatory and bonus modules implemented.
- Highlight technical specifications, model metrics, and evaluation.
- Document adherence to regulatory and explainability rules.
- Suggest future improvements aligned with real market needs.

## 2 Core Rules Compliance and Project Constraints

### 2.1 Legal and Regulatory Compliance

- **Decision-support only:** The system does not execute buy/sell orders.
- **No guarantees:** Avoids claims of profit or certainty.
- **Anomaly detection for protection:** Identifies suspicious activity for user awareness, not accusation.
- **Educational disclaimer:** All outputs are advisory and transparent.
- **Market fairness:** Aligns with BVMT and CMF principles.

### 2.2 Explainability Rules

- Each recommendation includes an explanation in natural language.
- Signals used for BUY / SELL / HOLD are visible to the user.
- Confidence and uncertainty levels are displayed to avoid black-box outputs.

## **2.3 AI / ML Rules**

- Models are justified and evaluated with RMSE, MAE, F1-score as applicable.
- Confidence bands and probability scores are included for forecasts.
- Interpretable models are preferred when possible.
- Avoid overfitting by using realistic BVMT data with missing values and low liquidity.

## **2.4 Data and System Design Rules**

- Multilingual support: Arabic + French for all news and sentiment analysis.
- Modular architecture: Data  $\rightarrow$  Models  $\rightarrow$  Decision Logic  $\rightarrow$  UI.
- Each module operates independently; a simple working pipeline is preferred over complex unstable systems.

## **2.5 Portfolio and Decision Rules**

- Only virtual capital is used for portfolio simulation.
- Recommendations are limited to BUY / SELL / HOLD.
- Alignment with investor profile (risk level) is mandatory.
- Performance metrics (ROI, Max Drawdown) are tracked honestly.

## **2.6 UI and UX Rules**

- Dashboard displays predictions, sentiment, and alerts clearly.
- Confidence scores are prioritized over absolute statements.
- Avoids information overload while maintaining transparency.

# **3 Deliverables and Technical Specifications**

## **3.1 Module 1: Price and Liquidity Forecasting**

**Status:** Completed

### Functionality

- Predicts T+1 and T+5 stock prices.
- Generates confidence intervals (upper/lower bounds).
- Visualizes historical vs forecasted prices in **StockAnalysis** dashboard.
- Highlights optimal entry/exit points based on liquidity.

### Model Architecture

- Optimized LSTM (Long Short-Term Memory) network.
- Inputs: OHLCV + RSI + MACD + Bollinger Bands + Volatility.
- Trained on historical BVMT stocks (2022–2025).

### Evaluation Metrics

- Validation Loss (Huber): 0.39
- RMSE: 0.25
- MAE: 0.36

*Note: RMSE is sensitive to high nominal stock prices (e.g., BIAT  $\sim$  90 TND).*

## 3.2 Module 2: Market Sentiment Analysis

**Status:** Completed

### Functionality

- Aggregates Tunisian financial news (Arabic + French).
- Sentiment analysis via Gemini 2.0 Flash (LLM) with fallback to keyword-based analysis.
- Computes normalized sentiment score (-1.0 to +1.0).

### Visualization

- Sentiment gauge/bar chart.
- List of recent news articles with date and source.

### **3.3 Module 3: Anomaly Detection (Market Surveillance)**

**Status:** Completed

#### **Functionality**

- Detects volume spikes ( $> 3\sigma$ ) and price shocks ( $> 5\%$ ).
- Validated using synthetic anomaly injections.

#### **Evaluation Metrics**

- Precision: 0.16
- Recall: 0.80
- F1-Score: 0.62

#### **Alerts**

- Real-time alerts displayed in Monitoring page.
- Explanations via integrated chatbot.

### **3.4 Module 4: Augmented Decision Agent and Portfolio**

**Status:** Completed

#### **Decision Agent**

- Aggregates forecast, sentiment, and indicators to generate BUY / SELL / HOLD recommendations.
- Fully explainable using Gemini 2.0; users can query “Explain why”.

#### **Portfolio Management**

- Virtual portfolio simulation (Initial capital: 10,000 TND).
- Tracks P&L, ROI, Sharpe Ratio, Max Drawdown.
- Visualizes asset allocation and historical performance.

### 3.5 Module 5: User Interface (Dashboard)

**Status:** Completed

- Market Overview: TUNINDEX, top gainers/losers, global sentiment.
- Stock Analysis: Interactive charts, forecasts, sentiment, indicators.
- Portfolio: Simulation and performance tracking tools.
- Chatbot: “Sahbi-generated” AI assistant for queries.

## 4 Bonus Features Implemented

- Real-time forecasting pipeline using `InferenceService`.
- LLM-powered explainability for recommendations.
- RAG-based chatbot assistant for natural language queries.
- Interactive trade simulation with immediate portfolio impact.

## 5 Recommendations for Future Improvements

- Upgrade to WebSocket-based real-time market data.
- Further hyperparameter tuning for improved LSTM RMSE.
- Expand frontend testing and user experience improvements.
- Explore reinforcement learning for enhanced portfolio optimization.