**Model Evaluation and Refinement Report**

**1. Models Evaluated**

* **ARIMA Model**
  + **MAE:** 1.0548
  + **RMSE:** 1.5550
  + **R-squared:** -0.0763
* **LSTM Model**
  + **MAE:** 0.0445 (initial) / 0.4833 (after tuning)
  + **RMSE:** 0.0796 (initial) / 0.6267 (after tuning)
  + **R-squared:** 0.9729 (initial) / -25733.6644 (after tuning)
* **Gradient Boosting Model**
  + **MAE:** 0.0375
  + **RMSE:** 0.1123
  + **R-squared:** 0.9461

**2. Evaluation Metrics Analysis**

* **ARIMA Model**
  + Performance was suboptimal, indicated by a negative R-squared value, which suggests poor fit to the data.
* **LSTM Model**
  + Initial performance was excellent with low MAE, RMSE, and high R-squared.
  + After hyperparameter tuning, performance degraded significantly, with an extremely negative R-squared, suggesting overfitting or issues with model configuration.
* **Gradient Boosting Model**
  + Demonstrated good performance with low MAE and RMSE and a high R-squared value. It provided a robust balance of accuracy and interpretability.

**3. Model Performance Visualization**

* **Residuals Plot for LSTM**
  + An error occurred when plotting residuals due to memory issues. The correct calculation of residuals was needed to ensure accurate residual plots.

**4. Hyperparameter Tuning**

* **LSTM Model Tuning**
  + Initial tuning provided promising results, but further tuning led to drastic performance degradation. This could indicate that the model might have been overfitted or other hyperparameters were not appropriately tuned.