Model Validation Report

Generated on: {{validation\_date}}

Validated by: {{validated\_by}}

Model File: {{model\_path}}

Task: {{task\_type}}

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## Model Metadata

Model Type: {{ModelMetaCheck.model\_type}}

Feature Count: {{ModelMetaCheck.n\_features}}

Feature Names: {{ModelMetaCheck.feature\_names}}

Training Rows: {{ModelMetaCheck.n\_train\_rows}}

Target Balance: {{ModelMetaCheck.target\_balance}}

## Performance Metrics

### Regression Metric

RMSE: {{summary.rmse2}}

MAE: {{summary.mae2}}

R²: {{summary.r22}}

Adjusted R²: {{RegressionMetrics.r2\_adjusted2}}

Median AE: {{RegressionMetrics.median\_ae2}}

MAPE/SMAPE: {{RegressionMetrics.mape\_label}}

Metric Notes:{{RegressionMetrics.notes\_text}}

### Regression Visuals

Visual diagnostics complement the numerical metrics by showing how predictions compare to actuals and whether residuals follow expected patterns.

### Predicted vs Actual

Shows how closely model predictions align with true target values. Points near the diagonal line indicate good predictive accuracy.

[[IMG:reg\_pred\_vs\_actual]]

### Residuals vs Predicted

Plots errors against predicted values. Random scatter around zero suggests well-specified model; visible patterns indicate potential bias.

[[IMG:reg\_residuals\_vs\_pred]]

### Residual Distribution

Histogram of residuals. A symmetric, bell-shaped distribution suggests errors are centered and approximately normal.

[[IMG:reg\_residual\_hist]]

### Residuals (Q–Q Plot)

Compares residual quantiles to a normal distribution. Close alignment with the diagonal line supports the assumption of normal errors.

[[IMG:reg\_qq]]

### Absolute Error (Box Plot)

Boxplot of absolute errors. Shows the spread and presence of outliers in model error magnitudes.

[[IMG:reg\_abs\_error\_box]]

### Absolute Error (Violin Plot)

Violin plot of absolute errors. Combines distribution shape with summary statistics to highlight variability and asymmetry in error magnitudes.

[[IMG:reg\_abs\_error\_violin]]

## Data Quality (Cleaned Data)

Missing (Train): {{DataQualityCheck.train\_avg\_missing}}

Missing (Test): {{DataQualityCheck.test\_avg\_missing}}

Columns With Missing (Train): {{DataQualityCheck.train\_cols\_missing}}

Columns With Missing (Test): {{DataQualityCheck.test\_cols\_missing}}

Constant Columns: {{DataQualityCheck.constant\_columns\_str}}

## Raw Data Validation

Total Rows: {{RawDataCheck.total\_rows}}

Total Columns: {{RawDataCheck.total\_columns}}

Average Missing: {{RawDataCheck.avg\_missing\_pct}}

Columns With Missing: {{RawDataCheck.columns\_with\_missing\_str}}

Duplicate Rows: {{RawDataCheck.duplicate\_rows}}

Constant Columns: {{RawDataCheck.constant\_columns\_str}}

## Correlation Analysis

### Top High-Correlation Feature Pairs (|r| ≥ Threshold)

**Note:** Displayed only if high-correlation pairs exist; otherwise, none are generated.

### Correlation Heatmap

[[IMG:correlation\_heatmap]]

Method: {{CorrelationCheck.method2}}, Threshold: {{CorrelationCheck.threshold2}},

Features plotted: {{CorrelationCheck.plotted\_features2}} of {{CorrelationCheck.n\_numeric\_features2}},

High-corr pairs ≥ threshold: {{CorrelationCheck.n\_pairs\_flagged\_ge\_threshold2}} (of {{CorrelationCheck.n\_pairs\_total2}})

Full CSV: {{CorrelationCheck.top\_pairs\_csv\_path}}

Pearson Correlation CSV: {{correlation\_pearson\_path}}

Spearman Correlation CSV: {{correlation\_spearman\_path}}

{{CorrelationCheck.notes\_text}}

## Variance Inflation Factor (VIF) Check

{{VIFCheck.note\_text}}

## Exploratory Data Analysis (EDA)

Summary Stats CSV: {{eda\_summary\_path}}

Missing Values CSV: {{eda\_missing\_path}}

**Distribution Plots**

{{eda\_count\_note}}

## Linear Regression Results (Full OLS Summary)

### OLS Regression Results

{{LinearStats.summary\_text}}

### OLS Coefficients (Regression)

## Stress Testing Results

{{StressTest.note\_text}}

## Input Cluster Coverage Check

A K-Means clustering algorithm was applied to the cleaned dataset to evaluate input space coverage. This analysis highlights the distribution of samples across different clusters, assisting in the identification of any imbalance or concentration that could affect model behavior.

Input cluster distribution (saved to CSV):{{InputClusterCheck.cluster\_csv}}

### Cluster Summary Table

{{InputClusterCheck.note\_text}}

### Cluster Distribution Plot

[[IMG:cluster\_plot]]

## Rule Engine Check

Overall Pass: {{RuleEngineCheck.overall\_pass\_str}}

Rule Details: {{RuleEngineCheck.rules\_text}}

## Model Contents Summary

### Model Class: {{ModelMetaCheck.model\_class}}

### Module: {{ModelMetaCheck.module}}

### Hyperparameters:

{{ModelMetaCheck.hyperparams\_text}}

### Attributes:

{{ModelMetaCheck.attributes\_text}}

## Explainability

### SHAP Summary Plot

SHAP (SHapley Additive exPlanations) is used to explain the impact of each input feature on the model's predictions. The SHAP summary plot below shows the magnitude and direction of influence of the top features across a sample of predictions. Features at the top have the highest average impact. Red indicates higher feature values, and blue indicates lower values. This plot helps identify which features the model relies on most and whether they align with domain knowledge. Only a subset of the test data is used for SHAP due to performance considerations.

{{SHAP.note\_text}}

[[IMG:shap\_beeswarm]]

### Top Features by Mean |SHAP| (Bar)

[[IMG:shap\_bar]]

### Top SHAP Features

{{SHAP.top\_features\_note}}