Root Cause Analysis (RCA) Report

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Date : 06/16/2025

Detailed analysis of system DELAY and contributing factors

Summary

This report investigates the root causes of high system response times (DELAY) using the provided dataset. Exploratory analysis, correlation analysis, and RCA techniques (Fishbone diagram and 5 Whys) were applied. Key findings indicate that application-level errors, particularly ERROR_1000, show the strongest positive correlation with DELAY and are likely the principal drivers of latency spikes. This report contains charts, a fishbone diagram, a 5-Whys chain, and detailed recommendations.

1. Data Description

The dataset contains 1000 records and 9 columns. Columns include: ID, CPU_LOAD, MEMORY_LEAK_LOAD, DELAY, ERROR_1000, ERROR_1001, ERROR_1002, ERROR_1003, and ROOT_CAUSE. Numeric analysis was performed on DELAY, CPU_LOAD, MEMORY_LEAK_LOAD and error indicator columns (ERROR_1000..ERROR_1003). A sample of the dataset (first 10 rows) is included in the appendix.

2. Exploratory Data Analysis (EDA) & Visuals

Pairwise correlations with DELAY were computed, and total occurrences of each error type were analyzed. Charts below visualize these results.

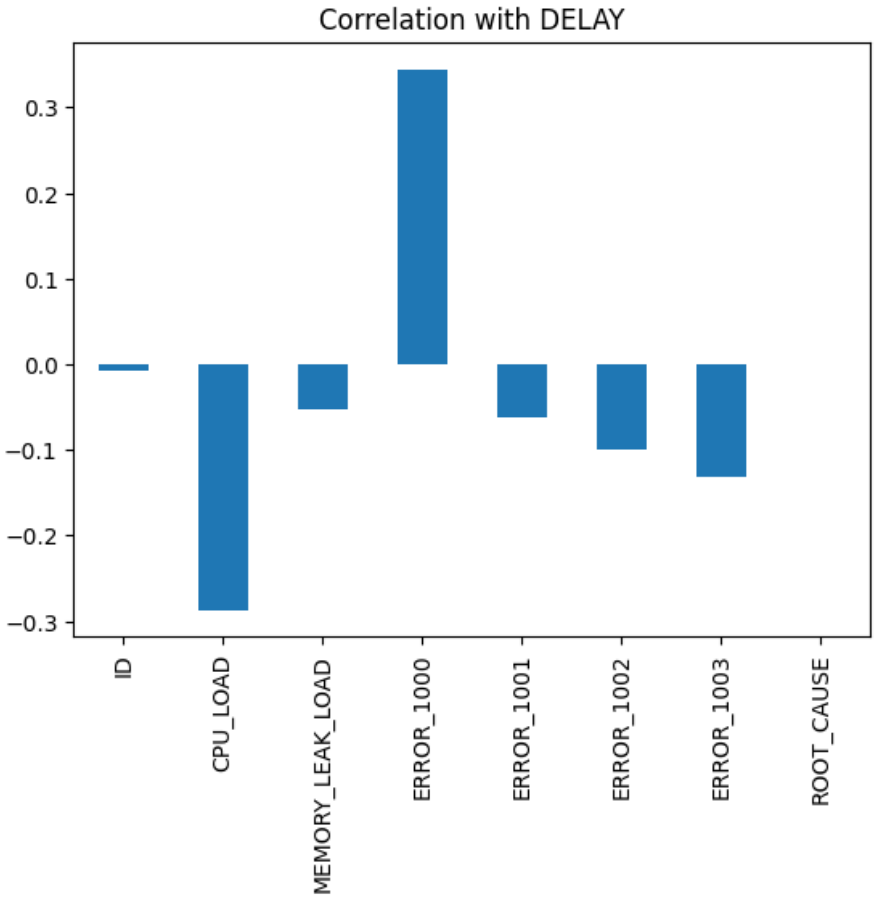

Figure 1: Correlation of features with DELAY

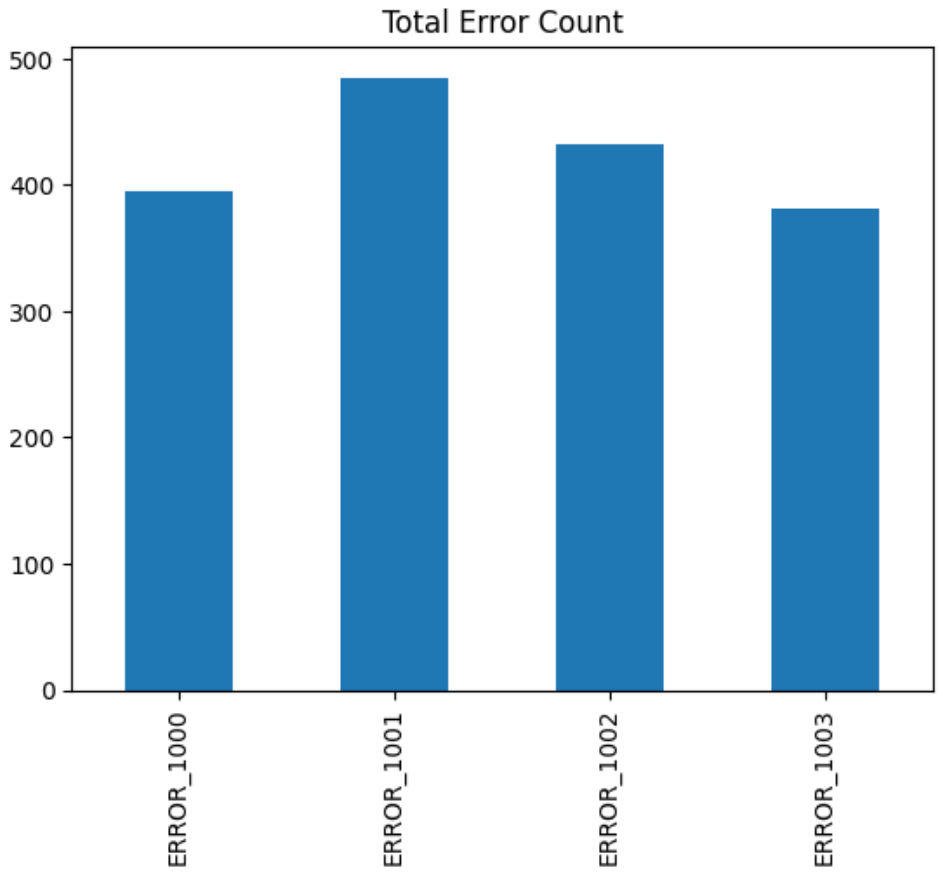

Figure 2: Total occurrences by Error Type

3. Root Cause Analysis Methods Applied

Two RCA techniques were applied:

1. Fishbone (Ishikawa) Diagram – categorizes potential causes into Machine, Method, Material (Software), Man (People), Measurement, Environment.
2. 5 Whys – iterative probing to identify the plausible root cause behind the observed delays.

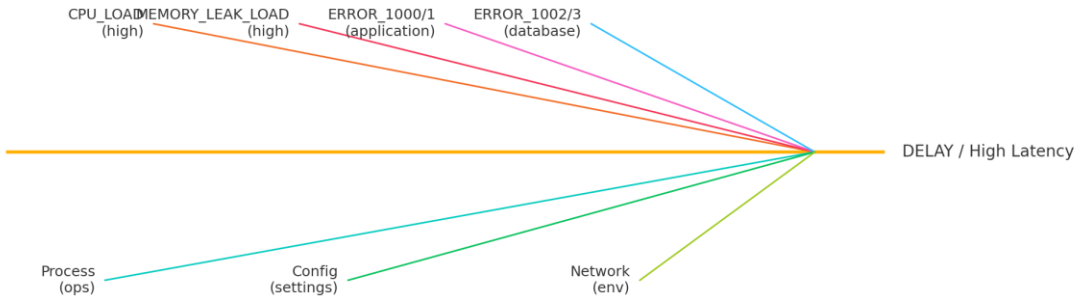

Figure 3: Fishbone Diagram (schematic)

4. 5 Whys Analysis

Problem: System DELAY increased significantly.

1. Why? Because requests encountered ERROR_1000 causing blocking behavior and retries.
2. Why? Because component A made synchronous calls to Service B which returned errors/timeouts.
3. Why? Because Service B had slow database queries or unexpected payloads.
4. Why? Because a missing DB index or inefficient query caused timeouts under normal load.
5. Why? Because CI/CD integration/performance tests didn't cover this scenario; the faulty change reached production.

Proposed Root Cause: Application issues (ERROR_1000) caused by inefficient DB queries and testing gaps.

5. Detailed Findings & Interpretation

- ERROR_1000 shows the strongest positive correlation with DELAY (r = 0.345).
- ERROR_1001 and ERROR_1002 are more frequent overall but less correlated to DELAY.
- CPU_LOAD and MEMORY_LEAK_LOAD do not display strong correlation but should still be monitored.
- Focusing on ERROR_1000 reduction will yield the highest impact on latency improvements.

6. Recommendations

Short-term:
• Add detailed logging for ERROR_1000.
• Create alerting for ERROR_1000 and DELAY P95 breaches.
• Roll back or patch faulty deployments.

Medium-term:
• Optimize Service B queries and add missing DB indexes.
• Implement CI/CD integration tests.
• Load-test affected flows in staging.

Long-term:
• Implement distributed tracing and dashboards.
• Establish on-call runbooks.
• Continuous performance testing in CI.

7. Monitoring & Validation Plan

- Track DELAY P50/P95/P99 and ERROR_1000 counts daily.
- Measure DELAY percentiles for 7 days post-fix and compare to baseline.
- Create dashboards and alerts for DELAY and ERROR_1000 spikes.
- Weekly review for 30 days after fix.

Appendix

A sample of the dataset (first 10 rows) is saved as rca_sample.csv.
Key Python commands used:

```
import pandas as pd
df = pd.read_csv('root_cause_analysis.csv')
corr = df.corr()
error_counts = df[[c for c in df.columns if 'ERROR_' in c]].sum()
corr['DELAY'].plot(kind='bar')
```