NVH Analysis Dashboard Report

Overview of Approach

The objective of this NVH (Noise, Vibration, and Harshness) analysis is to evaluate vehicle performance under different operating conditions and identify patterns that impact overall driving comfort. The analysis focuses on understanding how noise and vibration vary with road surface, speed, time, and vehicle characteristics, and how these factors influence perceived harshness.

The overall approach followed a structured workflow consisting of synthetic data generation, data preparation, exploratory analysis, interactive dashboard creation, and insight generation using Power BI.

Data Sources

The analysis is based on **synthetically generated datasets** designed to simulate real-world NVH measurement scenarios. The datasets were structured into three logical tables:

- **NVH_Measurements**:
  Contains timestamped measurements of Noise (dB), Vibration (RMS), vehicle speed, road surface type, and Vehicle_ID. This table represents the core operational NVH data.
- **Vehicle_Master**:
  Stores static vehicle attributes such as Vehicle_ID, Vehicle_Model, Engine_Type, Manufacturing_Date, and Region. This table enables vehicle-level segmentation and filtering.
- **Customer_Feedback**:
  Includes feedback dates, Harshness_Score, and general comfort-related feedback linked to Vehicle_ID. This dataset supports qualitative interpretation of NVH performance.

The synthetic dataset was generated to closely resemble realistic distributions observed in automotive NVH testing environments.

Assumptions and Data Preparation

Several assumptions were made during data preparation:

- The synthetic data accurately represents real-world NVH behavior across different road surfaces and speed ranges.
- Decimal formatting followed European (German) standards to ensure consistency during Power BI ingestion.
- Duplicate Vehicle_ID values in NVH_Measurements were intentionally preserved, as multiple measurements per vehicle are expected in real-world scenarios.

Data preparation steps included:

- Correcting data types for numeric and datetime fields.
- Ensuring consistent timestamp granularity.
- Creating calculated measures for average values and standard deviation using DAX.
- Establishing proper relationships between tables using Vehicle_ID as a logical key.

Dashboard Creation

The Power BI dashboard consists of **two main pages** designed for both high-level monitoring and detailed investigation:

1. NVH Overview Page

This page provides a consolidated view of key performance indicators and trends:

- KPI cards displaying Average Noise, Average Vibration, Average Harshness Score, and Noise Standard Deviation.
- Time-series analysis of noise trends to observe variation over the measurement period.
- Comparative analysis of noise and vibration across different road surfaces.
- Scatter analysis showing the relationship between vehicle speed and noise levels.
- Interactive slicers for Vehicle Model, Road Surface, Region, and Timestamp.

2. Vehicle Details Page

This page supports deeper analysis at an individual vehicle level:

- Drill-through functionality to inspect NVH measurements for a selected Vehicle_ID.
- Detailed tabular view of timestamped noise, vibration, speed, and road surface data.
- Associated customer harshness scores for contextual interpretation.
- Vehicle-level KPIs summarizing performance for the selected vehicle.

Key Insights

- Vehicles operating on rough road surfaces consistently exhibit higher noise and vibration levels compared to city and highway conditions.
- Noise levels show a positive correlation with vehicle speed, particularly at higher speed ranges.
- Vibration RMS values are noticeably higher on rough surfaces, indicating increased mechanical stress and reduced ride comfort.
- Vehicles with higher average noise and vibration tend to align with lower harshness scores, confirming the relationship between NVH metrics and perceived comfort.
- Time-based analysis reveals periodic fluctuations in noise levels, suggesting operational or environmental influences.

Recommendations

- Improve cabin insulation and damping materials for vehicles frequently operating on rough road conditions.
- Optimize suspension tuning to reduce vibration transmission at higher speeds.
- Use NVH trend monitoring to identify abnormal spikes that may indicate mechanical issues.

- Integrate customer harshness feedback more deeply with NVH metrics to prioritize comfort-related improvements.
- Extend the dashboard to support predictive analysis using historical NVH patterns.

Limitations

- The analysis is based on synthetic data, which may not fully capture all complexities of real-world vehicle behaviour.
- External factors such as weather conditions, driving behaviour, and vehicle load are not included.
- Customer feedback data is generalized and does not include detailed voice-of-customer narratives.
- The results should be validated with real sensor data before applying design or engineering decisions.

Conclusion

The NVH Analysis Dashboard provides a structured and interactive framework for understanding vehicle noise and vibration behaviour. By combining operational measurements with vehicle-level attributes and customer feedback, the dashboard supports data-driven decision-making for improving ride comfort and overall vehicle quality.