EDA / Machine Downtime

## Introduction:

In the competitive automotive manufacturing sector, unplanned machine downtime poses a significant challenge, leading to productivity losses and increased costs. This project addresses this issue for a leading vehicle fuel pump manufacturer, whose pumps are critical for ensuring high-velocity fuel transfer, directly impacting vehicle performance. The primary goal is to minimize unplanned machine downtime by at least 10% while keeping maintenance costs low, aiming to achieve cost savings of at least $1 million. By leveraging advanced analytics and targeted strategies, the project seeks to enhance operational efficiency, reduce downtime, and strengthen the manufacturer's competitive position in the market.

## Overall design strategy

The overall design strategy for this project involves a structured approach to minimize unplanned machine downtime while optimizing maintenance costs. The strategy begins with the extraction and analysis of relevant data from the manufacturing processes to identify patterns and root causes of downtime. Advanced analytics and machine learning techniques are employed to predict potential failures and schedule proactive maintenance. Key components of the strategy include:

1. \*\*Data Collection and Integration:\*\* Gathering data from various sources, including machine sensors, maintenance logs, and production records.

2. \*\*Root Cause Analysis:\*\* Identifying the primary factors contributing to unplanned downtime through detailed analysis.

3. \*\*Predictive Maintenance:\*\* Implementing predictive models to forecast equipment failures and schedule maintenance activities accordingly.

4. \*\*Process Optimization:\*\* Streamlining operational processes to enhance efficiency and reduce the likelihood of downtime.

5. \*\*Cost Management:\*\* Ensuring that maintenance activities are cost-effective and aligned with the overall business constraints.

By following this comprehensive design strategy, the project aims to achieve a significant reduction in unplanned downtime and realize substantial cost savings, thereby meeting the defined business and economic success criteria.

## Data Overview

The project utilized data from machine sensors, maintenance logs, production records, and failure reports. Sensor data provided real-time metrics like temperature and vibration, while maintenance logs and failure reports offered insights into historical issues. Production data linked downtime to productivity losses. This integrated dataset was analyzed to identify patterns, predict failures, and optimize maintenance schedules, aiming to reduce unplanned downtime and control costs effectively.Data is extracted into text files and when uploading into tableau all these files are joined based on the keys. Once the data is loaded another extract summarizing the team level data is created using custom SQL.

## Users

## **Maintenance Teams**:They will use the insights and predictive models to identify potential machine failures, schedule proactive maintenance, and reduce unplanned downtime.

## **Operations Managers**: They will rely on the system to monitor machine performance, optimize production schedules, and ensure minimal disruptions to the manufacturing process.

## **Plant Leadership**: Decision-makers will use the data-driven insights to allocate resources effectively, control maintenance costs, and improve overall operational efficiency.

## .Questions

## Questions that will be addressed by the machine downtime analysis and predictive maintenance system include:

## **Maintenance Teams:**

## - What are the most common causes of unplanned machine downtime?

## - Which machines are most prone to failures, and how frequently do they occur?

## - What are the key indicators (e.g., temperature, vibration) that predict machine failure?

## **Operations Managers:**

## - How does unplanned downtime impact overall production output?

## - What is the trend in machine performance over time?

## - How can maintenance schedules be optimized to minimize disruptions?

## **Plant Leadership:**

## - What are the cost implications of unplanned downtime versus proactive maintenance?

## - How can resources be allocated to reduce downtime while controlling costs?

## - What is the potential ROI of implementing predictive maintenance strategies?

## Describe Visualization and how it answers the questions

## **The visualizations in this project are designed to provide actionable insights into machine performance and downtime trends. Here’s how they address the key questions:**

## **- \*\*What are the most common causes of unplanned machine downtime?\*\***

## **- A \*\*bar chart\*\* or \*\*pie chart\*\* visualizes the frequency and root causes of downtime, helping maintenance teams prioritize issues.**

## **- \*\*Which machines are most prone to failures, and how frequently do they occur?\*\***

## **- A \*\*line graph\*\* or \*\*heatmap\*\* shows machine failure trends over time, highlighting high-risk equipment.**

## **- \*\*What are the key indicators (e.g., temperature, vibration) that predict machine failure?\*\***

## **- \*\*Scatter plots\*\* or \*\*time-series graphs\*\* display sensor data trends, enabling predictive maintenance.**

## **- \*\*How does unplanned downtime impact overall production output?\*\***

## **- A \*\*dashboard\*\* integrates downtime data with production metrics, showing correlations between downtime and output losses.**

## **- \*\*What is the trend in machine performance over time?\*\***

## **- \*\*Trend lines\*\* and \*\*performance charts\*\* track machine efficiency and downtime patterns over weeks or months.**

## **- \*\*What are the cost implications of unplanned downtime versus proactive maintenance?\*\***

## **- \*\*Cost-benefit analysis charts\*\* compare the financial impact of downtime versus maintenance investments.**

## **- \*\*How can resources be allocated to reduce downtime while controlling costs?\*\***

## **- \*\*Resource allocation heatmaps\*\* or \*\*Gantt charts\*\* optimize maintenance schedules and resource distribution.**

## **These visualizations provide clear, data-driven insights to help stakeholders make informed decisions, reduce downtime, and achieve cost savings.**

## Conclusion

In conclusion, this project addresses the critical issue of unplanned machine downtime in the manufacturing of vehicle fuel pumps, aiming to enhance productivity and reduce costs. By leveraging data from machine sensors, maintenance logs, and production records, we developed a comprehensive strategy to identify root causes, predict failures, and optimize maintenance schedules. The visualizations and predictive models provide actionable insights for maintenance teams, operations managers, and plant leadership, enabling them to make informed decisions. Achieving a 10% reduction in downtime and $1 million in cost savings will significantly improve operational efficiency and strengthen the manufacturer's competitive position in the market. This project demonstrates the power of data-driven approaches in solving complex industrial challenges.