OPTIMIZATION OF MACHINE DOWNTIME

Contents

Project Statements

- **Client :** One of the leading vehicle fuel pump manufacturers. These pumps are used to take fuel as input and push fuel as output at a high velocity. More the velocity, more is the seed at which vehicle will move.
- **Business Problem :** Machines which manufacture the pumps. Unplanned machine downtime which is leading to loss of Productivity.
    - **Business Objective :** Minimize unplanned machine downtime.
        - **Business Constraint** - Minimize maintenance cost.
- **Success Criteria:**
    - **Business Success Criteria** - Reduce the unplanned downtime by at least 10%.
    - **Economic Success Criteria** - Achieve a cost saving of at least $1M.

Project Overview and Scope

Project Overview:

We are working with one of the top manufacturers of vehicle fuel pumps. These pumps are essential because they control the vehicle's speed by pushing fuel at high velocities. However, the machines that produce these pumps are facing unplanned downtime, which is hurting productivity.

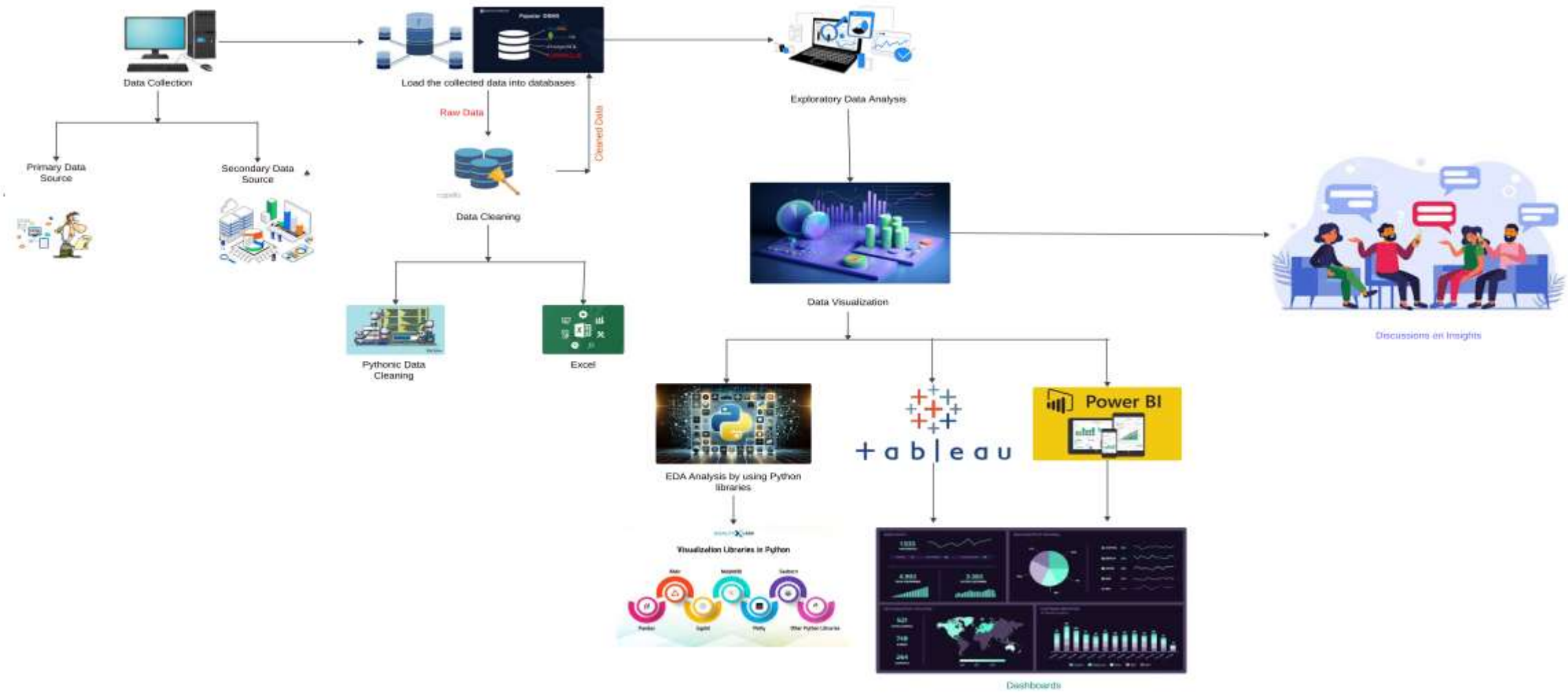
Project Scope:

Our goal is to reduce the unplanned downtime of these machines to boost productivity and minimize maintenance costs. Success will be measured by:

1.Reducing unplanned downtime by at least 10%.

2.Achieving a cost saving of at least $1 million in maintenance.

Project Architecture - Data Flow Diagram



Data Collection

Secondary Data Provided by the Company

Overview:

- **Company-Provided Data:** The company has shared existing data that was previously collected for other purposes.
- **Purpose:** We will use this data to conduct further analysis to meet our current project objectives.

Key Characteristics:

- **Relevant to the Project:** The data is specifically chosen because it aligns with our analysis goals.
- **Reliable Source:** As the data comes directly from the company, it is considered accurate and trustworthy.
- **Cost-Effective:** By using this existing data, we save time and resources compared to collecting new data.

Advantages:

- **Historical Context:** The data might include historical records that allow us to analyze trends over time.
- **Comprehensive Coverage:** It may cover a wide range of variables, providing a broad foundation for analysis.
- **Customized for Our Needs:** The company selected data that is most relevant to our specific project, ensuring that it is directly applicable to our analysis.

Data Dictionary

- **Column names & Datatypes :** Date DATE, Machine_ID VARCHAR(255), Assembly_Line_No VARCHAR(255), Hydraulic_Pressure FLOAT, Coolant_Pressure FLOAT, Air_System_Pressure FLOAT, Coolant_Temperature FLOAT, Hydraulic_Oil_Temperature FLOAT, Spindle_Bearing_Temperature FLOAT, Spindle_Vibration FLOAT, Tool_Vibration FLOAT, Spindle_Speed FLOAT, Voltage FLOAT, Torque FLOAT, Cutting FLOAT, Downtime VARCHAR(255).
- **Data Description :** The dataset contains the following columns:

  1.Date: The date of the recorded data.

  2.Machine_ID: Identifier for the machine.

  3.Assembly_Line_No: The assembly line number.

4.Hydraulic_Pressure(bar): The hydraulic pressure in bars.

5.Coolant_Pressure(bar): The coolant pressure in bars.

6.Air_System_Pressure(bar): The air system pressure in bars.

7.Coolant_Temperature: The coolant temperature in °C.

8.Hydraulic_Oil_Temperature(°C): The hydraulic oil temperature in °C.

9.Spindle_Bearing_Temperature(°C): The spindle bearing temperature in °C.

10.Spindle_Vibration(µm): The spindle vibration in micro meters.

11.Tool_Vibration(µm): The tool vibration in micro meters.

12.Spindle_Speed(RPM): The spindle speed in RPM.

13.Voltage(volts): The voltage in volts.

14.Torque (Nm): The torque in newton meters.

15.Cutting(kN): The cutting force in kilonewtons.

16.Downtime: The type of downtime recorded (e.g., "Machine Failure“ , “No Machine Failure”).

Exploratory Data Analysis [EDA]

Statistical Insights

- **Purpose:** Understand How Data is Distributed: See how the data is spread out and what the key numbers are.

  Spot Outliers: Find any unusual data points that might need more attention.

  Find Patterns: Look for relationships or trends between different variables.
- **Key Techniques:** Descriptive Statistics: Mean, Median, Mode: Basic averages and middle values.

Business Insights

- **Purpose:** Turn Statistical Insights into Business Actions: Focus on how data findings can help make better business decisions.

  Find Opportunities and Risks:Use the data to identify areas for improvement and potential problems.
- **Key Considerations:** Impact on Productivity: Example: Frequent downtime in certain machines might mean they need

Statistical Insights

Variance and Standard Deviation: How much the data varies.

Skewness and Kurtosis: The shape of the data distribution.

- **Correlation Analysis:** See how variables are related. Example: How machine downtime might be linked to production volume.
- **Distribution Plots:** Histograms, Boxplots: Visual tools to see data distribution and find outliers.

Business Insights

more focused maintenance.

Cost Impact:

Example: Machines with lots of downtime might be driving up maintenance costs.

Operational Efficiency:

Example: Adjusting machine schedules based on downtime patterns could improve efficiency.

Statistical Insights

- **What We Learned:**

  Example: High variance in machine downtime shows that machine performance is inconsistent.

  Example: A strong link between machine age and downtime suggests older machines break down more often.

Business Insights

- **What We Learned:**

  Example: Reducing downtime in key machines could boost overall production efficiency by 15%.

  Example: Focusing on the most problematic machines could save the company $500,000 a year in downtime costs.

Data Preprocessing

Data Preprocessing :

Data preprocessing is a crucial step in preparing your dataset for analysis. It involves several key tasks to ensure that the data is clean, consistent, and ready for use. For my project, I focused on two main aspects of data preprocessing: data cleaning and data transformation.

1.Data Cleaning:

a. Removing Errors: This involves identifying and correcting any mistakes or inaccuracies in the data. For example, I checked for and fixed any typos or incorrect values.

b. Handling Missing Values: I dealt with missing data by either filling in gaps with appropriate values or removing incomplete records. This helps to ensure that the analysis is accurate and reliable.

2. Data Transformation:

a. Normalization: I adjusted the data so that it fits within a common scale. This is important for ensuring that different variables are comparable and can be effectively analyzed.

b. Encoding: I converted categorical data into numerical formats that can be used in various analytical models. This step is necessary for algorithms that require numerical input.

By carefully cleaning and transforming the data, I made sure that it was in the best possible shape for analysis, leading to more accurate and meaningful insights.

Data Visualization

Visualizing Data with Python

1. What It Is: Data visualization turns data into charts and graphs to make it easier to understand and see patterns.

2. Tools I Used: I used Python to create these visualizations. Python has great tools for making charts.

3. Key Tools:

- Matplotlib: Makes basic charts like line and bar graphs.
- Seaborn: Helps create more stylish and easy-to-read charts.

4. How It Works:

- Prepare Data: Clean and organize the data first.
- Pick a Chart: Choose the right type of chart to show the data clearly.
- Make the Chart: Use Python tools to create the chart.

- Improve It: Add colors, labels, and titles to make it easier to understand.

5. Examples:

- Trends: Line charts to show how things change over time.
- Distribution: Histograms to show how often different values occur.
- Comparisons: Bar charts to compare different items.

6.Why It’s Useful:

- Clear: Makes complicated data easy to understand.
- Helpful: Helps spot important patterns and make better decisions.

Conclusion

This project effectively tackled the business problem by using data analysis to meet our objectives. We adhered to constraints and evaluated success through key criteria. By collecting, preprocessing, and visualizing data, we delivered clear insights and actionable recommendations, leading to better-informed decisions and improved outcomes.


THANK
YOU