**Project Overview: Enhancing Manufacturing Efficiency through Defect Analysis**

This project focuses on improving manufacturing efficiency by analysing defect-related data from various vendors, plants, and materials. Our objective is to identify recurring defect patterns and trends, which will enable the company to enhance product quality and operational efficiency. The key questions we address are:

* **Frequent Defect Types**: What types of defects are most common?
* **Problematic Materials**: Are certain materials more prone to defects than others?
* **Vendor and Plant Performance**: Are there differences in defect rates among various vendors and plants?

**Data Exploration**

**Data Sources:**

The data was collected from multiple Excel sheets, including defect logs, vendor information, plant IDs, and material types. The key tables used in this analysis are:

* **Defected Items**: The primary table containing defect records.
* **Vendor**: Metadata about vendors.
* **Plant**: Metadata about plants.
* **Material Type**: Information about material types.

**Data Size:**

* **Defected Items Table**: Over 6,000 records of defect occurrences.
* **Supporting Metadata Tables**: Around 300 entries each for vendors, plants, and materials.

**Data Quality:**

To ensure the analysis was accurate and meaningful, the following data cleaning tasks were performed:

* **Duplicate Removal**: Eliminated duplicate entries to avoid overcounting.
* **Handling Missing Data**: Addressed missing or incomplete records, especially in defect logs.
* **ID Mapping**: Ensured that the relationships between tables (e.g., linking Vendor ID, Material ID, and Plant ID) were consistent.

**Analytical Approach**

**Descriptive Analysis:**

Descriptive statistics and visualisations provided a clear overview of the data. Key findings include:

* **Frequent Defect Types**: A small number of defect types account for the majority of defects.
* **Problematic Materials**: Certain materials were found to be more prone to defects.
* **Vendor and Plant Performance**: Significant variations were identified in defect rates across vendors and plants.

**Key Analytical Methods:**

* **Pivot Tables and Power Queries**: Used to analyze categorical variables like defect types, materials, and vendors.
* **Data Cleaning**: Ensured data consistency by checking the accuracy of data types (e.g., numeric fields for quantities, dates formatted correctly).
* **Correlation Analysis**: Power Queries were employed to measure correlations between variables such as **Material ID & Defect Qty** and **Defect Type ID & Defect Qty**, revealing relationships between key variables.

**Key Findings**

1. **Frequent Defect Types**:
   * The most frequent defect (Defect Type ID: 247) had a defect quantity of **377**. This defect type should be prioritised for deeper investigation and corrective action.
2. **Problematic Materials**:
   * **Material ID: 60** had the largest quantity of defective items, with **1,377,228** defective units. This suggests a critical need for enhanced quality control for this material.
3. **Vendor and Plant Performance**:
   * A small number of vendors contributed to the majority of defects. By focusing on vendors with the highest defect rates, the company can streamline supplier quality control.
   * Certain plants exhibited higher downtime, as revealed by box plots. These plants should be prioritized for operational reviews to reduce inefficiencies.

**Visualisations and Dashboards**

* **Excel Charts**: Various charts (bar charts, histograms, box plots) were created to visually represent the relationships between vendors, materials, defect types, and plant performance.
* **Tableau Dashboards**: Interactive dashboards were developed in Tableau, allowing users to filter and explore the data dynamically, which helps in making data-driven decisions more accessible to stakeholders.

**Insights and Recommendations**

**1. Vendor Management:**

* **Action**: Prioritise working with vendors that have the highest defect rates. Implement stricter quality control measures and collaborate on joint improvement initiatives.
* **Recommendation**: Establish performance benchmarks and periodic reviews for vendors to ensure continuous quality improvements.

**2. Plant Process Improvement:**

* **Action**: Plants with high downtime and defect rates should undergo a detailed operational review to identify workflow inefficiencies.
* **Recommendation**: Consider process re-engineering and employee training at underperforming plants to optimise operational performance.

**3. Material Type Monitoring:**

* **Action**: Focus on materials with the highest defect rates (such as Material ID: 60). This may involve increasing quality control during procurement and production.
* **Recommendation**: Investigate whether switching suppliers or exploring alternative materials could reduce defect rates.

**Addressing the Original Problem:**

By focusing on the vendors and materials with the highest defect rates, and addressing specific plants with prolonged downtime, the company can significantly reduce operational inefficiencies and improve product quality.

**Limitations and Future Work**

**Limitations:**

* **Reporting Inconsistencies**: Some records, particularly those with zero defect quantities but recorded downtime, suggest possible inconsistencies in reporting. These inconsistencies may affect the reliability of the conclusions.
* **Data Scope**: The analysis is limited to the data provided, which may not fully capture all aspects of the production process (e.g., machine-level data or operator performance data).

**Future Work:**

* **Root Cause Analysis**: A deeper investigation into the root causes of defects is needed, potentially incorporating data on machine performance or operator activity to provide a more granular understanding of defect causes.
* **Cost Analysis**: Extending the analysis to include the cost implications of downtime and defects will help prioritise interventions based on financial impact.
* **Predictive Modelling**: Developing predictive models using historical defect data could help anticipate future defects and proactively prevent them.

**Conclusion**

This project has uncovered significant variations in defect rates across vendors, materials, and plants, pointing to clear opportunities for improvement. By focusing on high-impact areas—vendors with poor performance, problematic materials, and underperforming plants—the company can achieve significant reductions in defect rates, minimise downtime, and ultimately enhance product quality.

Implementing these recommendations will not only improve operational efficiency but also enhance the company's reputation for delivering high-quality products