

**Coding Challenge: Manufacturing Production & Quality Analysis**

A manufacturing company produces multiple product lines. The management wants to **improve production efficiency** and **reduce defective units**. They have shared their **production dataset**, and your task is to analyze it using **Python** and provide actionable insights.

**Dataset (Sample Columns)**

Column Name	Description
Date	Date of production (YYYY-MM-DD)
Plant_ID	Unique identifier of the manufacturing plant
Product_ID	Unique identifier of the product
Product_Category	Category of the product (e.g., Electronics, Automotive, Textile)
Units_Produced	Total units produced on that day
Units_Defective	Number of defective units
Machine_Downtime (hrs)	Machine downtime in hours
Labor_Hours	Total man-hours worked
Material_Cost (INR)	Raw material cost for that day
Production_Cost (INR)	Total production cost (including labor + machine + materials)
Revenue (INR)	Sales revenue generated

**Tasks**

**1. Data Cleaning & Preparation**

- Handle missing values, incorrect data types, and duplicates.
- Create new columns like:
  - **Defect Rate (%)**
  - **Profit**

Find out the defect rate and profit

## 2. Exploratory Data Analysis (EDA)

- Trend of production vs. defective units over time.
- Compare defect rates across different **plants** and **product categories**.
- Identify the relationship between **machine downtime** and **units produced**.
- Find top 5 most profitable products.

## 3. Data Visualization (using matplotlib / seaborn)

- Line chart of **production vs. defects** over time.
- Bar chart comparing **profit across product categories**.
- Heatmap showing correlation between numerical features.

## 4. Insights & Recommendations

- Which plant has the highest defect rate?
- Which product line is the most profitable?
- Does higher machine downtime significantly affect production?
- Suggest strategies to reduce costs and defects.

## Expected Deliverables

- **Jupyter Notebook (.ipynb) or Google colab with:**
  - Data cleaning steps
  - Exploratory analysis & visualizations
  - Insights and recommendations
- **Report (.pdf/.pptx) summarizing findings**