EDA / Descriptive Statistics

## Introduction:

This project focuses on optimizing raw materials to achieve efficient grades of steel. By analyzing the composition and sourcing of raw materials, we aim to enhance steel quality while minimizing costs and waste. This research seeks to develop strategies that streamline production processes and improve overall resource efficiency in steel manufacturing.

## Overall design strategy

The data which was extracted to get insights efficient grades of steel consisted of 312 records which covers information related Optimization of Raw Materials to Achieve Efficient Grades of Steel. This data is displayed in six dashboards to give insights.

To design a comprehensive strategy for optimizing raw materials in steel manufacturing based on the project's objectives and dataset with 312 records, consider the following approach:

1. **Data Analysis and Composition Study**

1. Objective: Analyze the composition of raw materials to understand their impact on steel quality.
2. Methodology: Use statistical analysis and data visualization to identify correlations between raw material composition (e.g., iron ore, coal, alloying elements) and steel quality metrics (e.g., tensile strength, hardness).
3. Visualization: Create scatter plots, correlation matrices, and histograms to visually explore relationships and distributions within the dataset.

**2. Sourcing Optimization**

1. Objective: Optimize raw material sourcing to minimize costs and enhance quality.
2. Methodology: Evaluate supplier performance based on cost-efficiency and material quality metrics derived from the dataset.
3. Visualization: Develop supplier performance dashboards and cost comparison charts to identify opportunities for cost savings and quality improvements.

**3. Waste Reduction Strategies**

1. Objective: Implement strategies to reduce waste during steel production.
2. Methodology: Analyze production records from the dataset to identify areas of waste generation and inefficiencies.
3. Visualization: Use Pareto charts, process flow diagrams, and heatmaps to pinpoint critical waste points and prioritize improvement efforts.

**4. Process Optimization and Efficiency**

1. Objective: Streamline production processes to improve resource efficiency.
2. Methodology: Utilize process data from the dataset to identify bottlenecks and inefficiencies.
3. Visualization: Develop process flow simulations and efficiency dashboards to visualize process improvements and monitor performance metrics.

**5. Environmental Impact Mitigation**

1. Objective: Reduce the environmental footprint of raw material extraction and processing.
2. Methodology: Calculate environmental metrics (e.g., carbon footprint, water usage) based on data from the dataset.
3. Visualization: Create environmental impact maps, trend charts, and sustainability scorecards to track progress towards environmental goals.

**6. Predictive Analytics and Future Planning**

1. Objective: Implement predictive models to forecast raw material requirements and optimize inventory management.
2. Methodology: Apply machine learning algorithms to historical data to predict future demand and variability in raw material inputs.
3. Visualization: Develop predictive analytics dashboards and scenario planning visualizations to support strategic decision-making.

**7. Implementation and Integration**

1. Objective: Integrate findings and strategies into operational practices to achieve sustained improvements.
2. Methodology: Collaborate with cross-functional teams to implement recommendations derived from data analysis.
3. Visualization: Use implementation roadmaps, change management dashboards, and performance scorecards to monitor and communicate progress.

## Data Overview

Data is extracted from primary data. Data will be collected to use in the visualization. Around 312 records are extracted.

Certainly! Here's a concise data overview for optimizing raw materials in steel manufacturing:

1. Raw Material Composition: Elemental data from iron ore, coal, and alloying elements.

2. Sourcing and Procurement: Supplier performance metrics and cost analysis.

3. Production Efficiency: Yields, waste metrics (scrap, emissions), and energy consumption.

4. Environmental Impact: Carbon footprint, water usage, and sustainability metrics.

5. Predictive Analytics: Historical production data and demand forecasting.

6. Operational Data: Equipment performance and process parameters.

These data points are crucial for analyzing, optimizing, and improving resource efficiency, cost-effectiveness, and environmental sustainability in steel manufacturing processes.

## Users

1. Improved Product Quality: Users benefit from steel products that meet or exceed industry standards in terms of strength, durability, and other desired properties. Optimized raw materials ensure consistent and reliable product quality.

2. Cost Savings: Efficient use of raw materials can lead to cost reductions through minimized waste, lower production costs, and better resource allocation. This translates to competitive pricing for steel products in the market.

3. Environmental Sustainability: Optimization often involves reducing the environmental footprint of steel production by using resources more efficiently and minimizing waste generation. This appeals to environmentally conscious consumers and stakeholders.

4. Enhanced Operational Efficiency: Steel manufacturers benefit from streamlined processes and improved operational efficiency, which can increase throughput and overall productivity.

5. Innovation and Differentiation: By optimizing raw materials, manufacturers can innovate with new steel grades or applications, potentially opening up new markets and opportunities for growth.

6. Compliance and Standards Adherence: Meeting or exceeding industry standards for steel quality ensures that products are compliant with regulatory requirements and meet customer expectations.

7. Long-term Reliability: Consistently producing high-quality steel through optimized raw materials enhances the reliability and longevity of applications in various industries, promoting customer satisfaction and loyalty.

Overall, the user of optimizing raw materials for efficient grades of steel encompass improved product performance, cost-effectiveness, sustainability, and market competitiveness.

## Questions

Questions which will be answered by this visualization:

* **Efficiency in Raw Material Usage:**

1. How can we maximize the yield of usable steel from each unit of raw material input?
2. What technologies or processes can help reduce waste during steel production?
3. Are there opportunities to reuse or recycle certain by-products of steel manufacturing?

* **Cost Optimization:**

1. How can we minimize costs associated with raw material procurement without compromising quality?
2. Are there alternative raw materials or suppliers that offer better cost-efficiency?
3. What strategies can be implemented to mitigate the impact of fluctuating raw material prices?

* **Environmental Impact:**

1. What steps can be taken to reduce the environmental footprint of raw material extraction and processing?
2. How can we ensure that our raw material choices align with sustainability goals?
3. Are there innovations in raw material sourcing that could lead to more sustainable steel production?

* **Data and Analytics:**

1. How can data analytics be leveraged to optimize raw material usage in steel manufacturing?
2. What key performance indicators (KPIs) should be tracked to monitor the efficiency of raw material utilization?
3. Are there predictive models or simulations that can forecast raw material requirements based on production schedules?

* **Technological Advances:**

1. What role can advanced technologies such as AI, machine learning, or automation play in optimizing raw material usage?
2. Are there opportunities to adopt Industry 4.0 practices to enhance raw material management?
3. How can digital twins or virtual simulations help in visualizing and refining the raw material optimization process?

* **Supply Chain Resilience:**

1. How can we build a resilient supply chain for raw materials to ensure continuous and reliable production?
2. What contingency plans should be in place to mitigate risks related to raw material supply disruptions?
3. Are there partnerships or collaborations that could strengthen our raw material sourcing strategy?

## Describe Visualization and how it answers the questions

### **Efficiency in Raw Material Usage:**

1. **Maximizing Yield of Usable Steel:**
   * **This visualization** a stacked bar chart showing the breakdown of raw material input into usable steel, waste, and losses. This could visually depict the percentage of input that translates into usable steel.
2. **Reducing Waste:**
   * **This visualization** a Clustard Bar chart tracking waste reduction over time with milestones or initiatives marked. This could illustrate the trend in waste reduction efforts.
3. **Opportunities for Reuse or Recycling:**
   * **This visualization** a Donut chart showing the percentage of by-products (such as slag or mill scale) that are reused, recycled, or disposed of. This could highlight the sustainability efforts in recycling.

### **Cost Optimization:**

1. **Minimizing Procurement Costs:**
   * **This visualization** a Scatter Plot comparing the costs of different raw materials or suppliers. This could visually identify which sources offer better cost-efficiency.
2. **Alternative Raw Materials:**
   * **This visualization** a scatter plot showing cost versus quality metrics (like steel strength or purity) for different raw materials. This could help in identifying cost-effective alternatives.
3. **Mitigating Price Fluctuations:**
   * **This visualization** a line graph depicting historical price trends of key raw materials. This could assist in developing strategies to manage price volatility.

### **Environmental Impact:**

1. **Reducing Environmental Footprint:**
   * **This visualization** a Stacked bar showing the carbon footprint of raw material extraction sites or processing facilities. This could visually highlight areas for improvement.
2. **Alignment with Sustainability Goals:**
   * **This visualization** a KPI with sustainability dashboard with key metrics (like water usage, emissions, and waste generation) tracked over time. This could show progress towards sustainability targets.
3. **Innovations in Sourcing:**
   * **This visualization** a radar chart comparing sustainability criteria (such as renewable energy use or recycling rates) across different sourcing innovations. This could illustrate potential benefits of adopting new technologies.

### **Data and Analytics:**

1. **Optimizing Raw Material Usage:**
   * **This visualization** a Stacked bar chart dashboard with interactive charts showing real-time utilization metrics (like yield rates and efficiency ratios) across production lines. This could aid in continuous optimization.
2. **Key Performance Indicators (KPIs):**
   * **This visualization** a line chart or KPI scorecard or gauge chart o summarizing metrics like raw material usage efficiency, waste reduction percentages, and production cost per unit. This could provide a quick overview of performance against targets.
3. **Predictive Models:**
   * **This visualization** a line graph comparing predicted versus actual raw material consumption over a production timeline. This could demonstrate the accuracy and value of predictive models.

### **Technological Advances:**

1. **Role of Advanced Technologies:**
   * **This visualization** a Line chart or infographic illustrating how AI, machine learning, and automation optimize different stages of raw material management. This could visually depict the integration of technologies.
2. **Industry 4.0 Practices:**
   * **This visualization** a Line chart twin simulation showing the virtual representation of raw material flows within a steel plant. This could visualize how digital technologies enhance operational efficiency.
3. **Digital Twins and Simulations:**
   * **This visualization** a Scatter or 3D model or virtual reality simulation of a steel manufacturing process, highlighting areas where raw material optimization strategies are applied. This could provide a virtual walkthrough of process improvements.

### **Supply Chain Resilience:**

1. **Building a Resilient Supply Chain:**
   * **This visualization** a KPI with Slicer illustrating the interconnectedness of raw material suppliers, transportation routes, and manufacturing facilities. This could visualize potential supply chain risks and dependencies.
2. **Contingency Planning:**
   * **This visualization** a Line chart or risk heatmap showing the likelihood and impact of disruptions from different raw material suppliers. This could aid in prioritizing risk mitigation strategies.
3. **Partnerships and Collaborations:**
   * **This visualization** a radar chart or infographic showcasing key partnerships and collaborations in the raw material supply chain. This could highlight synergies and strategic alliances.

## Conclusion

In conclusion, By leveraging the dataset with 312 records, this comprehensive design strategy aims to optimize raw material usage in steel manufacturing. Through rigorous data analysis, strategic sourcing, waste reduction initiatives, process optimization, and environmental stewardship, the project seeks to enhance steel quality, reduce costs, and improve overall resource efficiency. Implementing predictive analytics ensures adaptability to future challenges, positioning the organization for sustainable growth and competitiveness in the steel industry.