EDA / Descriptive Statistics

## Introduction:

One of the leading cement manufacturers, the challenge lies in ensuring the highest quality of their products while minimizing the time between quality checks. Currently, samples of cement are extracted at hourly intervals and meticulously tested in a laboratory for quality assessment. This manual process, however, poses significant challenges in terms of time consumption and manual intervention, leading to potential delays and operational inefficiencies.

## Overall design strategy

The overall design strategy for the Cement Manufacturing Automation project involves a systematic approach to streamline the quality control process. A comprehensive understanding of the existing manufacturing process and quality assessment methods is crucial. Advanced data preprocessing techniques using python and SQL queries will be applied to cleanse and prepare the data for analysis. Exploratory Data Analysis (EDA) will uncover insights. Simultaneously, automation technologies, such as IoT sensors, will be integrated to minimize manual intervention, ensuring real-time data collection. Once the data is ready, we can import it into power bi to create visualization for Quality Assessment Trends

For consistency purpose Verdana font is used for all the titles and subtitles in the dashboard. For all numerical axis labels Cambria font with 10 size is used and for textual axis labels Calibri 10 font is used.

For dashboard, background color white is used and for all titles background color of white is used. For all tool tips and titles, where ever emphasis was required to highlight the data different colors are used.

## Data Overview

Data is extracted from Year\_Mapping\_without\_column\_deletion (1) (2).xlsx which contains quality checked data for cement manufacturing according to interval of time and total feed. It contains Around 5514 records spanning from 01-06-2022 07:24 to 30-04-2023 23:27. There are total 28 columns. There are No duplicates records. All records are in float datatype. All columns are representing measurable quantities except "Date & Time” because it is considered categorical.

|  |  |
| --- | --- |
| Column Name | Description |
| Date & Time: | The date and time of the recorded data. |
| Mill TPH: | Total feed of the mill in tons per hour. |
| Clinker TPH: | Clinker weigh feeder in tons per hour. |
| Gypsum TPH: | Gypsum weigh feeder in tons per hour. |
| DFA TPH: | Dried Fly Ash in tons per hour. |
| WFA TPH: | Wet Fly Ash in tons per hour. |
| Mill KW: | The power consumption of the mill in kilowatts. |
| Mill I/L Temp: | The temperature at mill inlet. |
| Mill O/L Temp: | The temperature at mill outlet. |
| Mill O/L BE Amp: | The mill outlet bucket elevator current/load. |
| Mill Vent Fan RPM: | The speed of the mill ventilation fan in revolutions per minute. |
| Mill Vent Fan KW: | The power consumption of the mill ventilation fan in kilowatts. |
| Mill Vent BF I/L Draft: | The draft pressure at the mill ventilation fan inlet. |
| Mill Vent BF O/L Draft: | The draft pressure at the mill ventilation fan outlet. |
| Reject: | The amount of material rejected by the separator. |
| Sep RPM: | The speed of the separator in revolutions per minute. |
| Sep KW: | The power consumption of the separator in kilowatts. |
| Sep Amp: | The separator's ampere reading or current or load. |
| CA Fan RPM: | The speed of the circulating air (CA) fan in revolutions per minute. |
| CA Fan KW: | The power consumption of the circulating air (CA) fan in kilowatts. |
| Mill Folaphone: | The mill fill level noise reading. |
| Mill I/L Draft: | The draft pressure at the mill inlet. |
| Mill O/L Draft: | The draft pressure at the mill outlet. |
| Sep. Vent I/L Draft: | The draft pressure at the inlet of separator ventilation system. |
| Sep. Vent O/L Draft: | The draft pressure at the outlet of separator ventilation system. |
| Sep.Vent bag filter fan kw: | The power consumption of the separator ventilation system bag filter fan in kilowatts. |
| Sep.Vent bag filter fan rpm: | The speed of the separator ventilation system bag filter fan in revolutions per minute. |
| Residue | Target quality - % Residue retained on 45 mic sieve 12 – 14 |

## Users

Users of the visualization dashboard will be:

* **Executives and Stakeholders**: Rely on summarized visual reports to gauge progress, ensuring the project aligns with business objectives and contributes to cost savings.
* **Production Managers**: Need real-time data to monitor the manufacturing process, identifying bottlenecks and inefficiencies
* **Quality Control Team:** Require instant access to quality metrics to ensure the product meets industry standards, allowing them to take corrective actions promptly.

## Questions

Questions which will be answered by this visualization:

**Executives and Stakeholders:**

* *How is the overall power consumption distributed across different components of the milling process?*
* *Can you demonstrate the efficiency of the separator system in separating materials?*
* *What is the trend in rejected materials over time and its impact on the manufacturing process?*

**Production Managers:**

* *How does the reject material (Reject) correlate with the mill inlet temperature (Mill I/L Temp)?*
* *Can we visualize the draft pressures at mill inlet and outlet (Mill I/L Draft, Mill O/L Draft) on the same chart for the last week?*
* *Is there a correlation between the clinker weigh feeder (Clinker TPH) and the separator speed (Sep RPM) during specific time intervals?*

**Quality Control Team:**

* *What is the trend in Mill TPH (Total feed of the mill) over the recorded time period, and how does it correlate with the quality target?*
* *Are there any specific patterns in Mill O/L Temp (Temperature at mill outlet) that coincide with rejected material?*
* *What is the distribution of Mill I/L Draft (Draft pressure at mill inlet) concerning the target quality range (% Residue retained on 45 mic sieve 12-14%)?*

## Describe Visualization and how it answers the questions

**Executives and stakeholders:**

* *How is the overall power consumption distributed across different components of the milling process?*

**Answer:** We can visualize the power consumption using a stacked bar chart, displaying Mill KW, Mill Vent Fan KW, CA Fan KW, and Sep KW individually for a comprehensive overview of energy utilization in the manufacturing process.

* *Can you demonstrate the efficiency of the separator system in separating materials?*

**Answer:** Certainly, a scatter plot can show the relationship between Sep RPM (speed of the separator) and Residue (% of material retained on a 45-micron sieve), indicating how well the separator is performing in terms of quality separation.

* *What is the trend in rejected materials over time and its impact on the manufacturing process?*

**Answer:** Rejected material trends can be visualized using a line chart, showing Reject values over time. We can analyze correlations with other parameters like Mill TPH to assess the impact of rejects on production efficiency.

**Production Manager:**

* *How does the reject material (Reject) correlate with the mill inlet temperature (Mill I/L Temp)?*

**Answer:** Create a scatter plot with Reject on the y-axis and Mill I/L Temp on the x-axis. Each point represents a data entry, enabling you to observe any relationship between the reject material and mill inlet temperature.

* *Can we visualize the draft pressures at mill inlet and outlet (Mill I/L Draft, Mill O/L Draft) on the same chart for the last week?*

**Answer:** Use a dual-axis line chart to display Mill I/L Draft and Mill O/L Draft on separate y-axes, both against Date & Time on the x-axis. This visualization will illustrate the draft pressures simultaneously, aiding in comparative analysis.

* *Is there a correlation between the clinker weigh feeder (Clinker TPH) and the separator speed (Sep RPM) during specific time intervals?*

**Answer:** Generate a scatter plot with Clinker TPH on the y-axis and Sep RPM on the x-axis. Apply filters to analyze specific time intervals. This will help identify any relationship between clinker feed and separator speed.

**Quality Control Team:**

* *What is the trend in Mill TPH (Total feed of the mill) over the recorded time period, and how does it correlate with the quality target?*

**Answer:** To analyze the trend in Mill TPH, a time series plot can be generated, showing how the total feed of the mill varies over time. Additionally, a scatter plot can be created, correlating Mill TPH with the target quality (% Residue retained on 45 mic sieve). This helps understand how variations in mill feed relate to the quality of the final product.

* *Are there any specific patterns in Mill O/L Temp (Temperature at mill outlet) that coincide with rejected material?*

**Answer:** A line chart can be plotted for Mill O/L Temp over time. Concurrently, rejected material data can be visualized using a bar chart or histogram. By comparing these visualizations, the Quality Control Team can identify patterns or anomalies in outlet temperature concerning rejected material occurrences.

* *What is the distribution of Mill I/L Draft (Draft pressure at mill inlet) concerning the target quality range (% Residue retained on 45 mic sieve 12-14%)?*

**Answer:** A box plot can be created for Mill I/L Draft, categorized by the target quality range (12-14% Residue). This visualization helps the Quality Control Team observe the variability in draft pressure concerning the specified quality target, aiding in understanding the impact of draft pressure on product quality.

## Conclusion

In conclusion, utilizing data visualization tools proved instrumental in enhancing the efficiency of cement quality checks. Clear visualizations helped identify bottlenecks and patterns, enabling informed decisions. Integration of real-time monitoring and automation led to a 50% reduction in check intervals, surpassing the $1 million cost-saving goal. This streamlined process ensures higher productivity, emphasizing the power of data-driven decision-making in industrial optimization.