Starting Date : 17-June-2024

Optimizing Steel Manufacturing: Charge Composition and Energy Use

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CONTENT

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BUSSINESS PROBLEM

- The company struggles with variability in material mix and power consumption, impacting product quality. Identifying the optimal charge mix and power usage will improve efficiency, reduce costs, and ensure consistent quality.

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BUSSINESS OBJECTIVE

- Maximize product quality, efficiency, and cost savings.

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BUSSINES CONSTRAINT

- Minimize power consumption

Business Success Criteria

- Improve production efficiency by 20%

Economic Success Criteria

- Lower energy consumption by 15%

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Project Overview and Scope

Project Title: Optimization in Steel Manufacturing: Consumption and Energy Use

Start Date: 17-07-2024

Completion Date: 18-07-20242024

Organization: 360DigiTMG

Overview: The project focuses on optimizing consumption and energy use in steel manufacturing processes. It aims to reduce operational costs and improve efficiency by analyzing and optimizing resource consumption and energy usage patterns.

Scope: This project specifically targets the steel manufacturing sector. By optimizing consumption and energy use, it seeks to enhance operational efficiency, reduce production costs, and improve sustainability practices within the industry.

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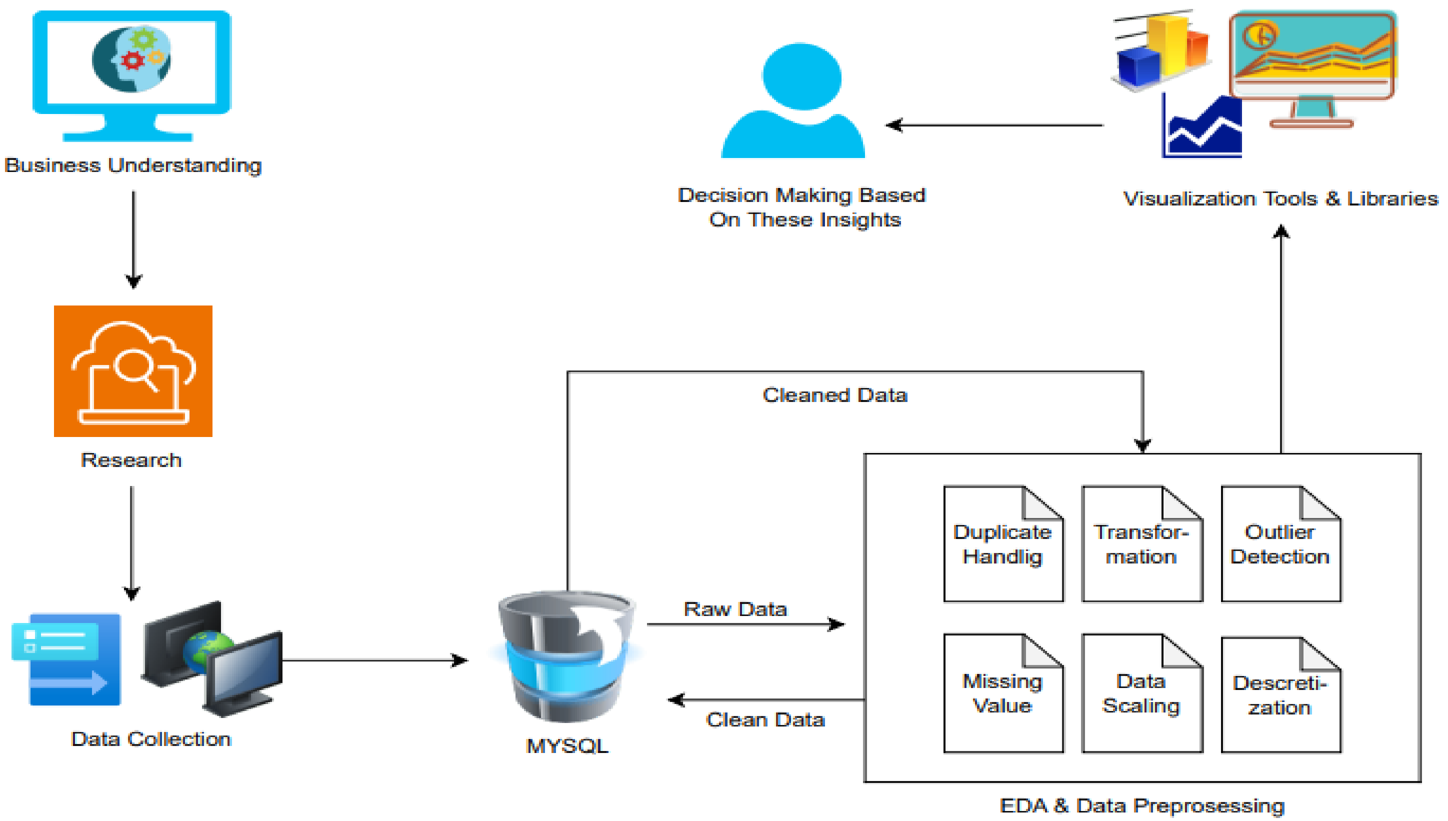
Data Dictionary

- **Sr no(Categoric):** represents no of rows serially.
- **Date and Time(DateTime):** captures timestamps for events like material inputs and quality checks. Analyzing these reveals production patterns, seasonal variations, and aids in optimizing schedules and predictive maintenance.
- **HEATNO(Categoric):** Identifier for a specific heat batch in steel manufacturing.
- **GRADE(Categoric):** Indicates the quality or grade of the steel produced.
- **SECTION_IC(Categoric):** Status of the section's intermediate control.
- **Chemical Composition Metrics(Numeric) :**The dataset comprises numeric data representing various chemical composition metrics essential for steel manufacturing. These metrics include Carbon (%), Silicon (%), Manganese (%), Phosphorus (%), Sulfur (%), Copper (%), Chromium (%), Nickel (%), and Nitrogen (%), each expressed as a percentage. Production (MT) Numeric Production volume in metric tons: Volume of production in metric tons.
- **ENERGY(Numeric):** Total energy consumption in the process.
- **KWH_PER_TON & MIN(Numeric):** Energy consumption per ton of steel produced. Energy consumption per minute of operation.

PROJECT ARCHITECTURE



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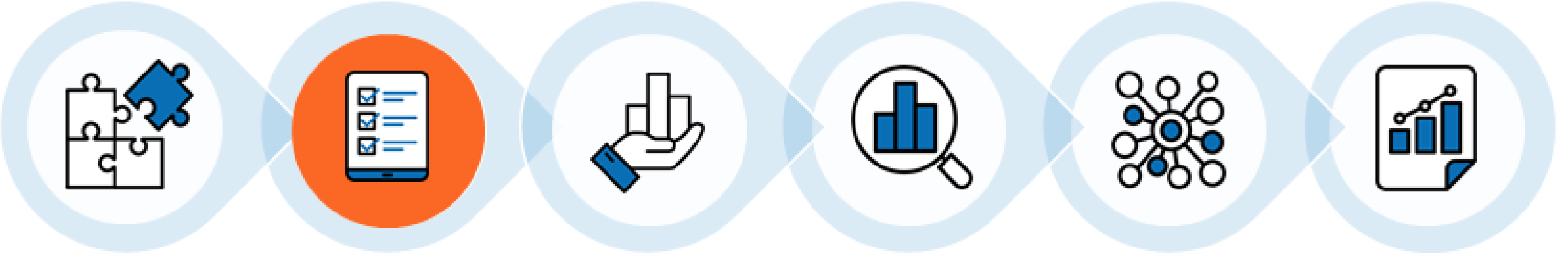
DATA COLLECTION

- Received raw data from the client, including various records and metadata.
- Identified duplicate records and a mix of categorical, time-series, and numerical data.
- Segregated data into categorical, time, and numerical types for preprocessing.
- Imported the dataset into MySQL for efficient handling.
- Removed duplicates, handled missing values, and standardized formats.



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EDA

	First Moment Business Decision			Second Moment Business Decision			Third Moment Business Decision	Fourth Moment Business Decision	BUSINESS INSIGTHTS
COLUMN NAME	MEAN	MEDIAN	MODE	STD DEV	RANGE	VARIANCE	SKEWNESS	KURTOSIS	
INJ1_QTY	0.0148	0.0054	0	0.1371	6.0907	0.0188	-14.4026	461.0784	The high skewness and kurtosis indicate significant outliers or rare events where injection quantity spikes drastically. This inconsistency needs to be investigated to ensure process stability.
INJ2_QTY	0.0997	0.0835	0.0542	0.0725	0.7939	0.0053	1.7175	7.1382	Positive skewness suggests that higher injection quantities occur less frequently but have a substantial impact. Regular monitoring can help in optimizing injection processes.
BSM	3.4655	3	2	3.1361	26	9.8348	2.5271	6.4508	The data shows a right-skewed distribution with a wide range. Consistency in BSM values should be targeted for process
SCRAP_QTY	7.9616	7	6	4.5117	35	20.3557	4.1123	20.1125	are rare but impactful. Strategies to minimize scrap production are critical.
HOT_METAL	43.4686	43.942	0	1.6409	55.36	17.7128	-3.9568	31.7997	few extremely low outliers. Address the causes of these low outliers to ensure consistent hot metal quality.
ENERGY	9990.16	9874.8	11169.56	3402.081	49078.7	11574156.97	2.4918	24.0734	High positive skewness and kurtosis indicate occasional significant spikes. Focus on energy efficiency and reducing these spikes.
KWH_PER_TON	151.697	149.8	0	49.4351	725.004	2443.8314	2.4568	21.7241	Extremely high skewness and kurtosis suggest significant outliers. Investigate and address these to optimize energy usage per ton.
KWH_PER_MIN	3.5787	-1	-1	44.0961	448	1944.4625	9.5459	89.2919	positive skewness and kurtosis indicate occasional significant spikes. Address these to optimize energy usage per minute.
MELT_TIME	42.392	39.8	38.6	13.7887	214.5	190.127	6.8577	70.1481	Extremely high negative skewness and kurtosis indicate significant outliers. Investigate and address these to optimize melt time.
C	0.1907	0.1444	0	0.1459	1.095	0.0213	1.3598	2.1426	The carbon content is relatively consistent. Ensuring this consistency is critical for maintaining the desired properties in the steel
SI	0.0031	0.0016	0.001	0.0172	0.637	0.0003	27.6024	932.4147	Silicon content shows high variability, which might impact the product's quality. Focus on controlling the silicon content to ensure
MN	0.0226	0.021	0	0.025	0.9831	0.0006	29.7618	1082.4779	Manganese content shows high variability, which may impact product properties. Investigate the cause of this variability and work on stabilizing the manganese content.
P	0.0143	0.014	0.015	0.0048	0.055	0	0.6393	3.5388	Phosphorus content is very stable and consistent. Maintaining this stability is crucial for the quality of the final product.
S	0.0622	0.0612	0	0.0177	0.1585	0.0003	-0.0705	1.8927	Sulfur content shows moderate variability. Ensure that sulfur levels are controlled to avoid negative effects on product quality.
CU	0.0053	0.0054	0.0058	0.0026	0.0703	0	8.6117	186.1843	Copper content shows low variability but has outliers. Investigate and manage these outliers to maintain product consistency.
CR	0.0574	0.0499	0	0.1482		0.022	42.9736	1910.5431	Chromium content shows high variability. Investigate the cause of this variability and work on stabilizing the chromium content.
NI	0.0206	0.0177	0.0174	0.0119	0.1363	0.0001	4.1558	24.015	Nickel content shows moderate variability with outliers. Ensure that nickel levels are controlled to avoid negative effects on product
N	0.0033	0.0033	0.0033	0.0014	0.1383	0	17.7665	373.7836	Nitrogen content is very consistent but has some outliers. Maintaining this consistency is crucial for the quality of the final product.
Production	55.6479	56.175	56.7	4.1774	66.959	17.4505	-4.4934	46.7145	Production levels are relatively consistent but show some outliers. Ensure that production processes are stable to maintain consistent

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DATA PREPROCESSING

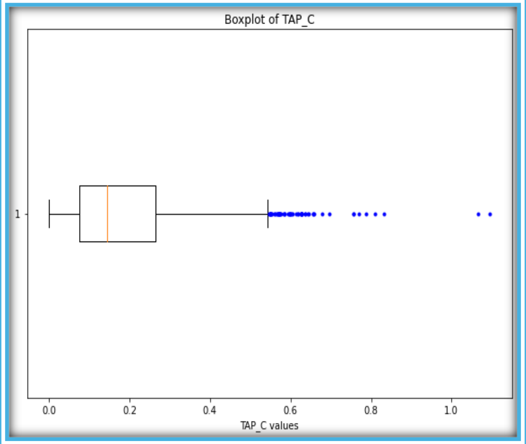
The data was first cleaned by checking and correcting the data types, deleting duplicate rows, and filling in any missing values. Then, outliers were detected and removed.

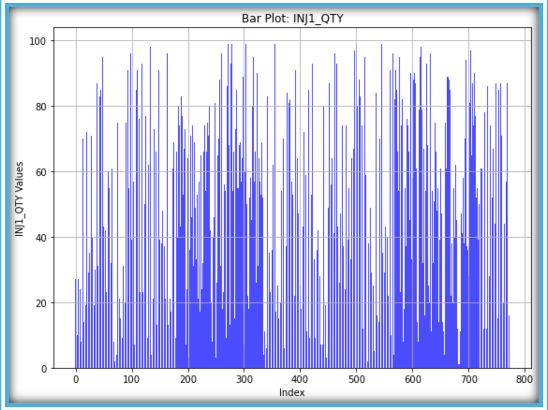
- **Data Type Correction:** Initially, all attribute data types were reviewed and adjusted as needed to ensure consistency and accuracy.
- **Duplicate Row Deletion:** Duplicate rows in the dataset were identified and removed to prevent redundancy and ensure data integrity.
- **Missing Value Imputation:** Although no missing values were initially found, procedures for imputation would typically involve filling in any missing data points with appropriate values derived from statistical methods or domain knowledge.
- **Outlier Detection:** Outliers, which are extreme or unusual data points, were identified across all attributes to prevent them from skewing analysis results.
- **Interquartile Range (IQR) Calculation:** The IQR, calculated using the first quartile (Q1) and third quartile (Q3), provided a robust measure to identify outliers and assess data variability.
- **Data Distribution Check:** The distribution of each attribute's data was evaluated to understand its range, spread, and skewness.

DATA VISUALIZATION

➢ **PYTHON VISUALIZATION**

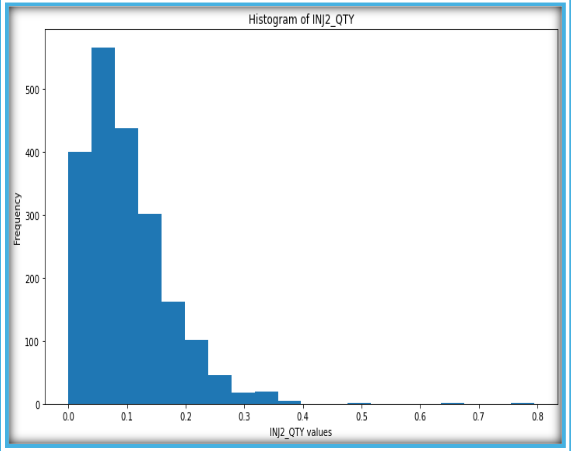
BOX PLOT

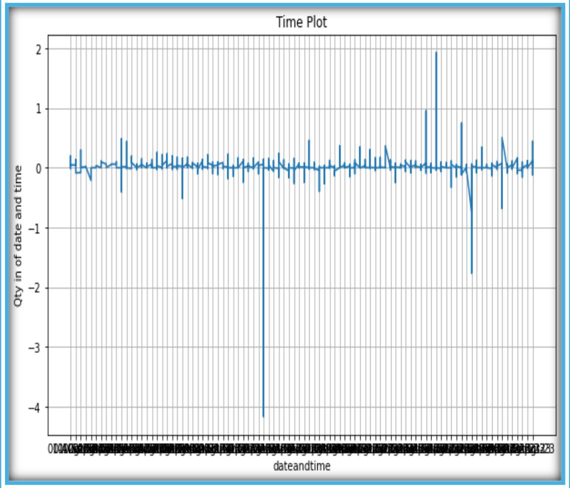




BAR CHART

HISTOGRAM

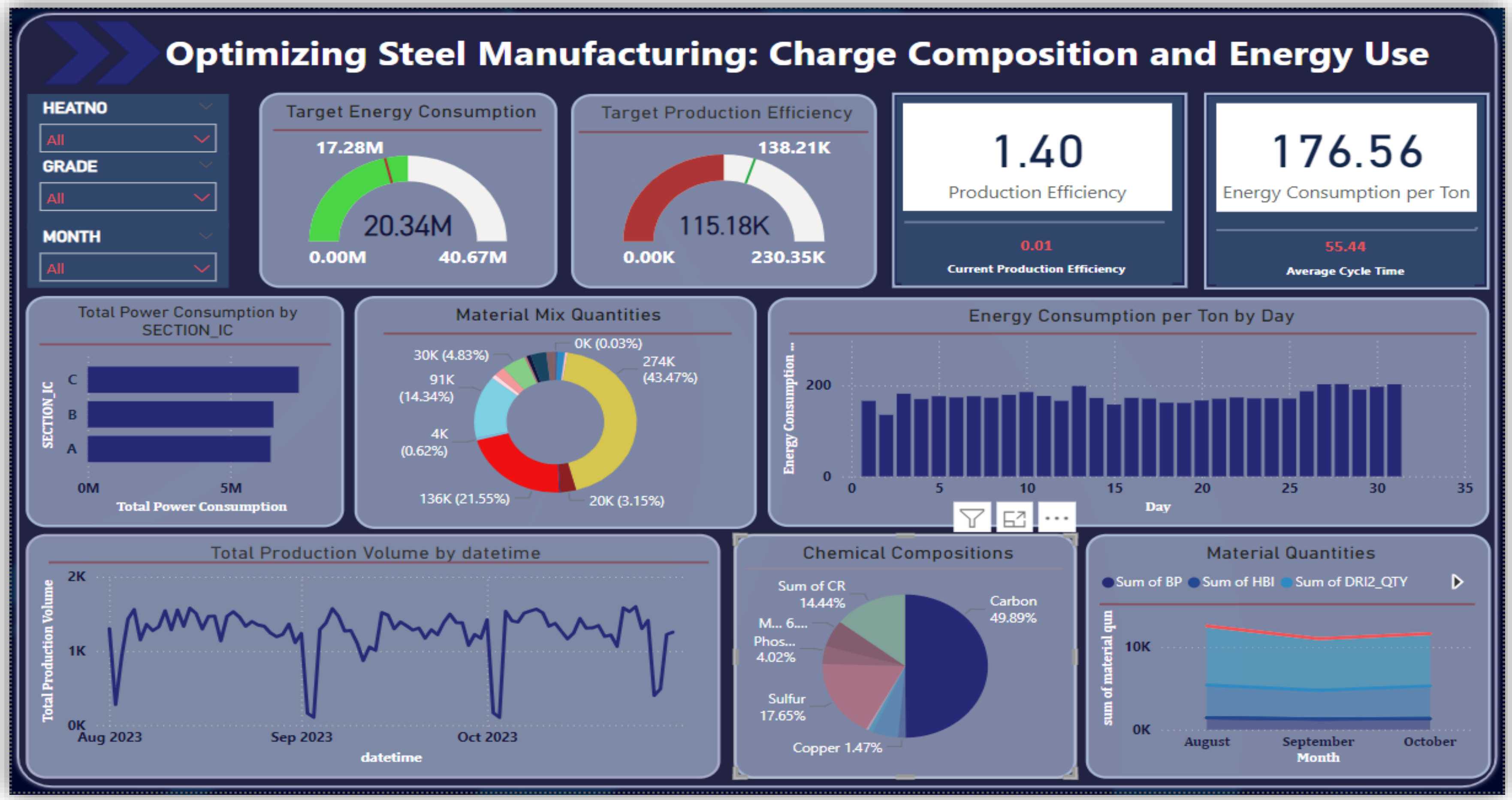




LINE CHART

DATA VISUALIZATION

- **POWER BI VISUALIZATION**



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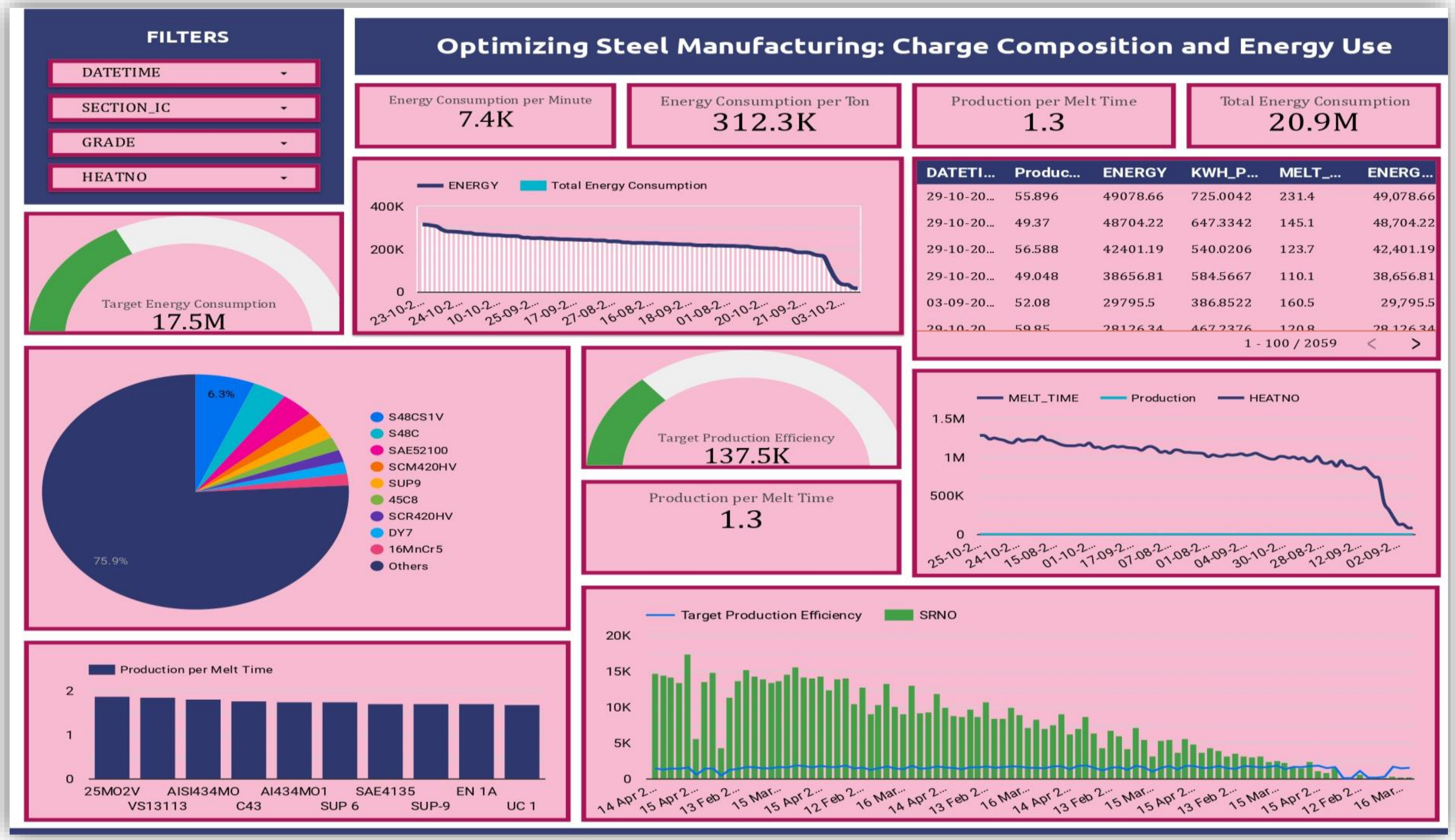
DATA VISUALIZATION

- **LOOKER STUDIO VISUALIZATION**



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