DATA CURATION PROJECT

ELECTRIC VEHICLE CHARGING STATIONS

PRESENTED BY

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UNDER GUIDANCE OF DR.BORIS GLAVIC

Agenda:

- Objective
- Dataset Introduction
- Data Quality Overview
- Framework used in Data Curation Process
- Data Cleaning and Transformation Tasks
- Tools used
- Results and Insights
- Conclusion

Objective

- The primary objective of this project is to harness the power of data curation techniques, specifically focusing on data cleaning and transformation processes.
- Through meticulous data curation, our aim is to refine and cleanse the dataset, ensuring its accuracy and reliability.
- By employing various data cleaning methods and transformative approaches, we intend to enhance the overall quality of the dataset.

Dataset Introduction :

Data source:

https://afdc.energy.gov/fuels/electricity_locations.html#/analyze?fuel=ELEC

Data source metadata:

https://afdc.energy.gov/data_download/alt_fuel_stations_format

	Original Dataset	Modified Dataset
Attributes	74	32
Size	22.7MB	568 KB
Data Format	CSV	CSV

Column reduction due to:

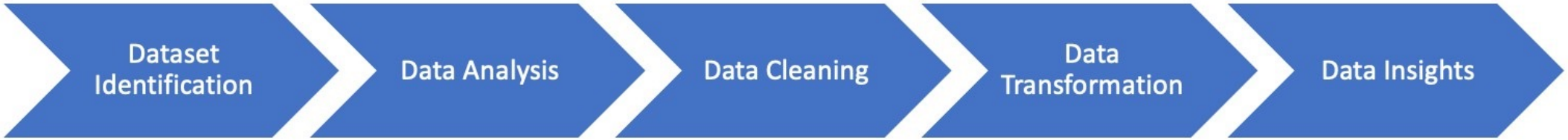
- Deprecated columns as per metadata
- No curation tasks in the removed columns
- Many null/blank values

Data Quality Overview:

- Data quality relates to its accuracy, completeness, consistency, and validity. Identifying data quality issues and correcting them, we would need data that is ideal for use.
- Data quality issues arises due to following factors:
  - Inaccurate Data
  - Incomplete Data
  - Duplicate Data
  - Inconsistent Data
  - Unstructured Data
  - Irrelevant Data
- We have identified such problems in our source dataset which we will discuss in further slides.

Framework used in Data Curation Process:

- We have used framework in data curation that uses a wide range of activities and processes done to create, manage, maintain, validate and showcase.
- Process Diagram :



Tools used for Problem Identification and Curation

Identification:

1. Microsoft Excel Spreadsheet
2. Vizier visualization

Curation :

1. Vizier Tool
2. Jupyter Notebook
3. Python Libraries :

- Pandas - Pandas is a Python library for data analysis and data manipulation. It offers data structures and operations for manipulating numerical tables and time series.
- Re - Regex library for performing regular expression related operations over data.

Data Cleaning and Transformation Tasks:

1. **Handling Missing Values:**
   - Imputed missing values in numeric columns ('EV_DC_Fast_Count').
   - Filled categorical columns with appropriate defaults ('EV_Network,' 'Provider,' 'Owner_Type_Code,' etc.).
2. **Column Renaming:**
   - Renamed 'EV_Network_Web' to 'Provider'.
3. **Regex Pattern Matching:**
   - Categorized 'Groups_With_Access_Code' values as 'Public' or 'Private' using regex patterns.
4. **Time Information:**
   - Modified 'Access_Days_Time,' categorized as "24 hours daily" or "Less than 24 hours"
5. **Credit Card Information:**
   - Transformed 'Cards_Accepted' into binary columns ('Credit,' 'Debit,' 'Cash,' 'No Payment Info').
6. **Special Character Removal:**
   - Removed special characters from 'Station_Name'
7. **Value Replacement:**
   - Replaced specific values like 'NAME?' with 'NIU' in 'Station_Name' and null values with 'Not Available' in 'Station_Phone'
8. **Handling Multiple Phone Numbers:**
   - Retained the first phone number if multiple in 'Station_Phone'
9. **Filling Missing Phone Numbers:**
   - Replaced missing phone numbers in 'Station_Phone' with 'Not Available'

Challenges during data curation:

- **Data Quality Issues:**
  1. Incomplete or missing data.
  2. Inconsistent data formats.
  3. Data inaccuracies or errors.
- **Data Heterogeneity:**
  -Dealing with diverse data types and formats.
- **Metadata Complexity:**
  1. Developing and managing comprehensive metadata.
  2. Ensuring consistency in metadata across datasets.
- **External Dependencies:**
  -Managing changes or disruptions in external data such as deprecations of columns.

Solutions to data curation problems:

In [14]:
```
import pandas as pd
df = pd.read_csv('Cleaned_Dataset.csv')
# Replace missing values in 'EV_DC_Fast_Count' column with 0
df['EV_DC_Fast_Count'] = df['EV_DC_Fast_Count'].fillna(0)
#df.to_csv('Cleaned_Dataset.csv', index=False)
```

In [15]:
```
import re
import numpy as np
df['EV_Network'] = df['EV_Network'].fillna('Non-Networked')
df=df.rename(columns={'EV_Network_Web': 'Provider'})
df['Provider']=df['Provider'].fillna('Not Applicable')
df['Owner_Type_Code']=df['Owner_Type_Code'].fillna('Unknown')
df['LPG_Primary']= df['LPG_Primary'].fillna('FALSE')
df['E85_Blender_Pump']= df['E85_Blender_Pump'].fillna('FALSE')
df['EV_Connector_Types']= df['EV_Connector_Types'].fillna('NA')
df['Access_Detail_Code']= df['Access_Detail_Code'].fillna('CALL')
df['CNG_Dispenser_Num']=df['CNG_Dispenser_Num'].fillna(0)
df['Restricted_Access']=df['Restricted_Access'].fillna('TRUE')
df['EV_Workplace_Charging']=df['EV_Workplace_Charging'].fillna('FALSE')
df['Facility_Type']=df['Facility_Type'].fillna('OTHER')

# Define regex patterns for Public and Private for Groups With Access Code Column
public_pattern = re.compile(r'\bpublic\b', flags=re.IGNORECASE)
private_pattern = re.compile(r'\bprivate\b', flags=re.IGNORECASE)
# Applying regex patterns to categorize values as Public and Private
df['Groups_With_Access_Code'] = df['Groups_With_Access_Code'].apply(lambda x: 'Public' if public_pattern.search(x) else 'Pri
```

Solutions to data curation problems(Continued):

```
21
22 df["Access_Days_Time"] = df["Access_Days_Time"].fillna("NULL")
23 df["Access_Days_Time"] = np.where(df["Access_Days_Time"].str.contains("24 hours daily"), "24 hours daily", "Less than 24
24
25 #Cards_Accepted column transformation into 4 columns i.e. Credit,Debit,Cash,No Payment Info
26 df["Credit"] = np.where(df["Cards_Accepted"].str.contains("CREDIT"), 1, 0)
27 df["Cash"] = np.where(df["Cards_Accepted"].str.contains("Cash"), 1, 0)
28 df["Debit"] = np.where(df["Cards_Accepted"].str.contains("Debit"), 1, 0)
29 df["No Payment Info"] = np.where(df["Cards_Accepted"].isna(), 1, 0)
30 df=df.drop("Cards_Accepted", axis=1)
31
32 #Removing the Special Character from Station Name
33 df['Station_Name'] = df['Station_Name'].apply(lambda x: re.sub(r'^[^a-zA-Z0-9]+', '', x))
34 # Replace 'Name?' with 'NIU' if present
35 df['Station_Name'] = df['Station_Name'].replace('NAME?', 'NIU')
```

In [21]:

```
1 # Filling missing values in Station_Phone column with 'Not Available'
2 df['Station_Phone'] = df['Station_Phone'].fillna('Not Available')
3 # If there are multiple phone numbers, choose one (here we are choosing the first one)
4 df['Station_Phone'] = df['Station_Phone'].apply(lambda x: x.split()[0] if ' ' in str(x) else x)
5 # Replace 'Not' with 'Not Available' in the 'Station_Phone' column
6 df['Station_Phone'] = df['Station_Phone'].replace('Not', 'Not Available')
```

In [22]:

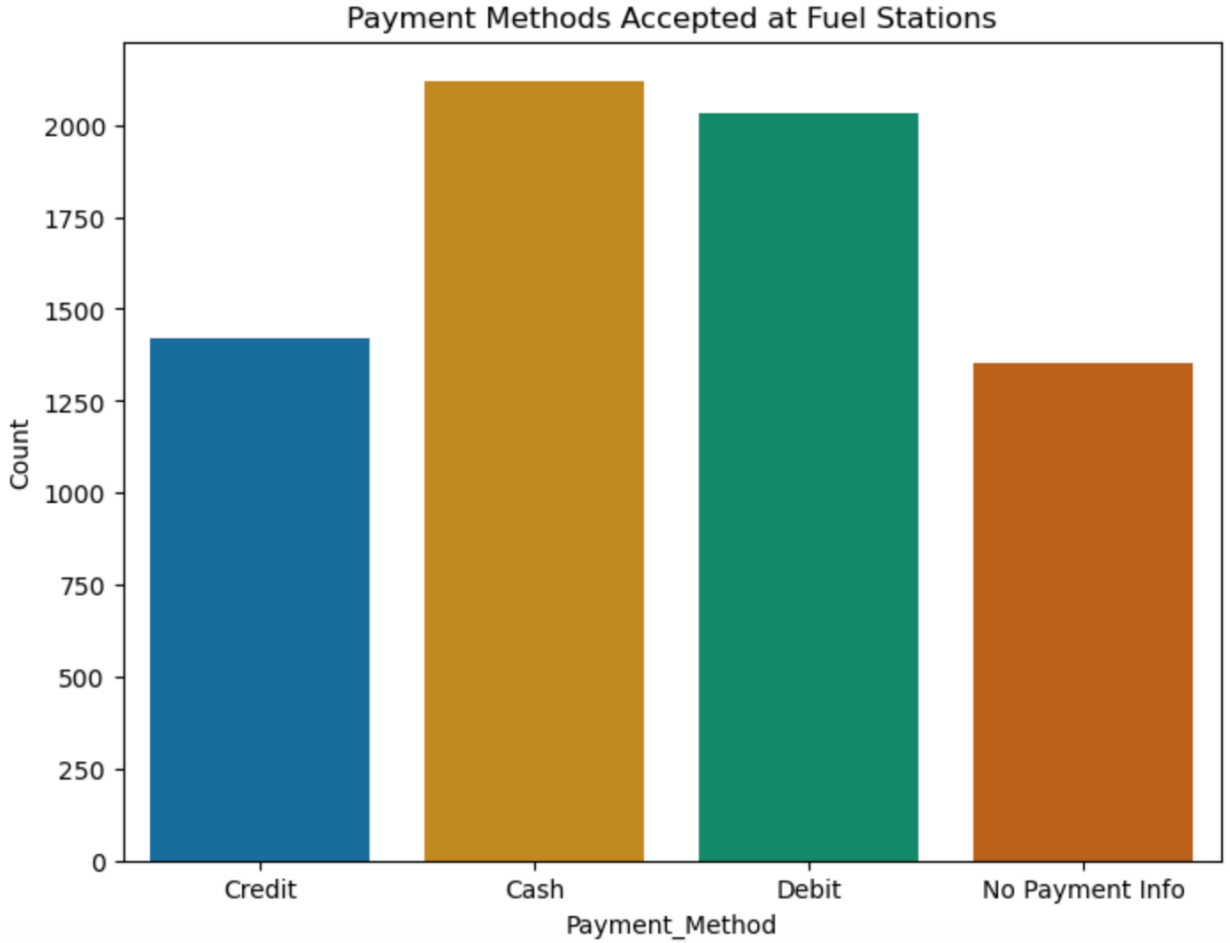
```
1 df.to_csv('Cleaned_Dataset.csv', index=False)
```

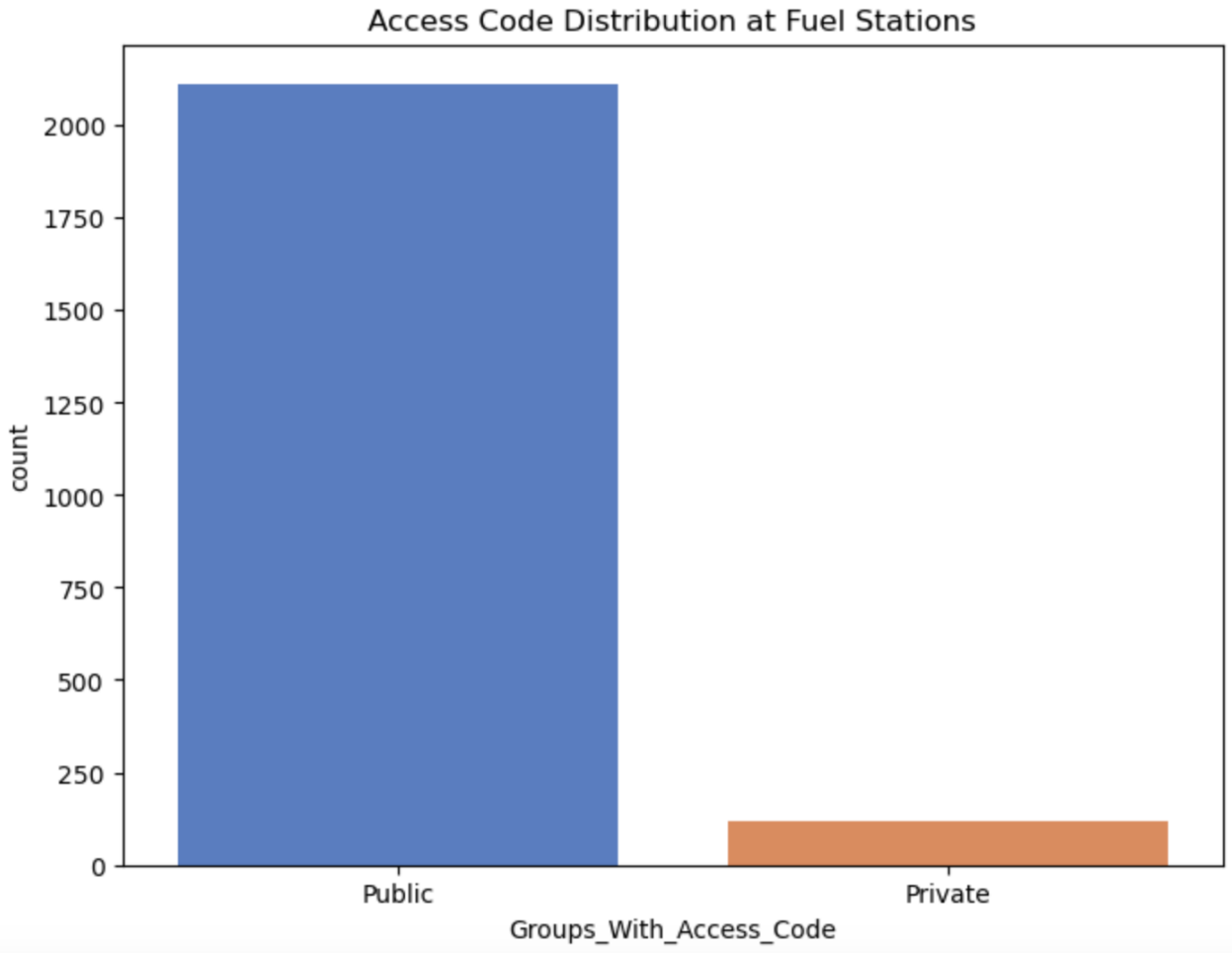
Results and Insights:

- Cleaned and transformed Data Results

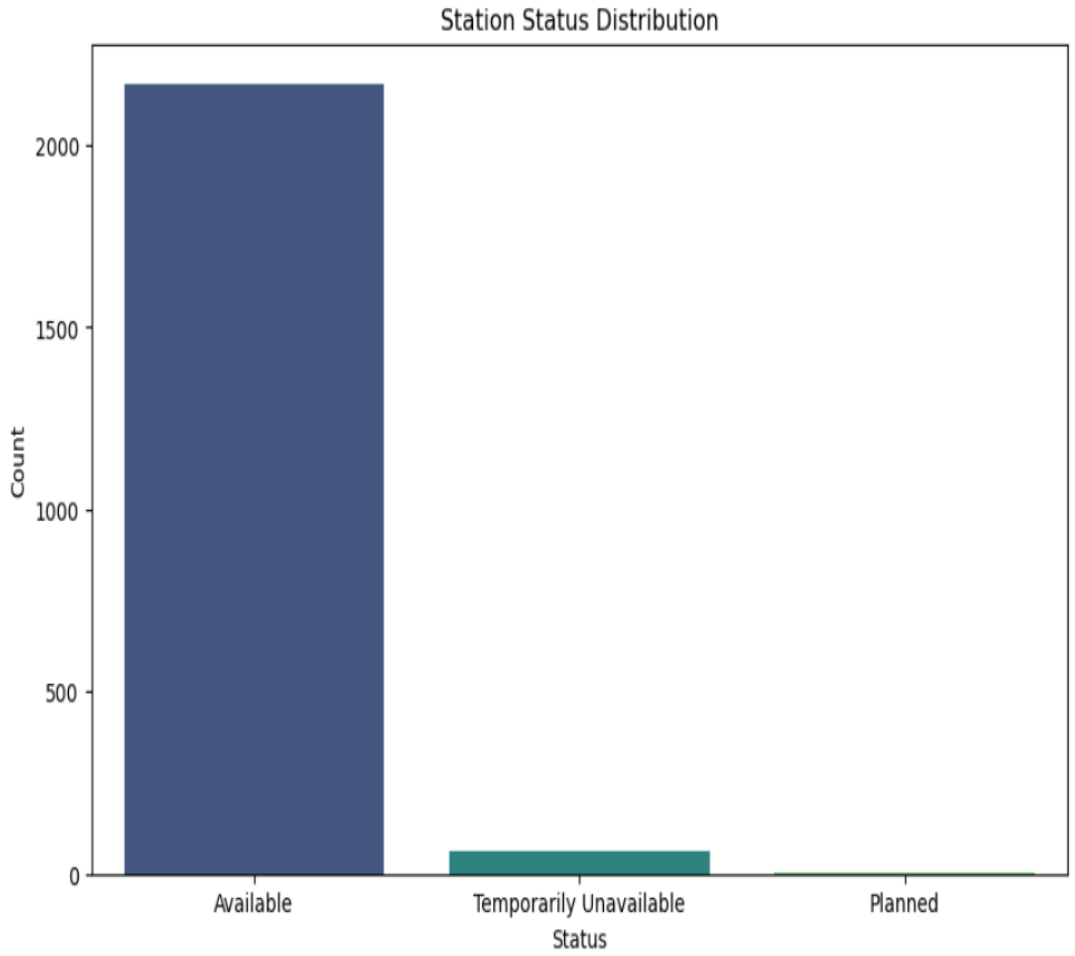
	Fuel_Type_Code	Station_Name	Street_Address	City	ZIP	Station_Phone	Status_Code	Groups_With_Access_Code	Access_Days_Time
0	LPG	Ferrellgas	10522 N 2nd St	Machesney Park	61115	815-877-7333	E	Public	Less than 24 hours
1	LPG	U-Haul	1560 Mount Prospect Rd	Des Plaines	60018	847-298-1170	E	Public	Less than 24 hours
2	LPG	U-Haul	2915 W 159th St	Markham	60428	708-333-7840	E	Public	Less than 24 hours
3	LPG	U-Haul	4650 W 95th St	Oak Lawn	60453	708-422-2332	E	Public	Less than 24 hours
4	LPG	U-Haul	1700 N Cicero Ave	Chicago	60639	773-889-8194	E	Public	Less than 24 hours
5	LPG	U-Haul	4301 N Cicero Ave	Chicago	60641	773-286-4507	E	Public	Less than 24 hours
6	LPG	U-Haul	1650 E 71st St	Chicago	60649	773-493-1206 708-389-0852	E	Public	Less than 24 hours
7	LPG	U-Haul	5027 W Cermak Rd	Cicero	60804	708-656-8890	E	Public	Less than 24 hours
8	LPG	U-Haul	306 E University Ave	Champaign	61820	217-351-7040	E	Public	Less than 24 hours
9	LPG	U-Haul	410 N Bruns Ln	Springfield	62702	217-546-2730	E	Public	Less than 24 hours
10	E85	Citgo	4070 N Clark St	Chicago	60613	773-528-3040	E	Public	24 hours daily

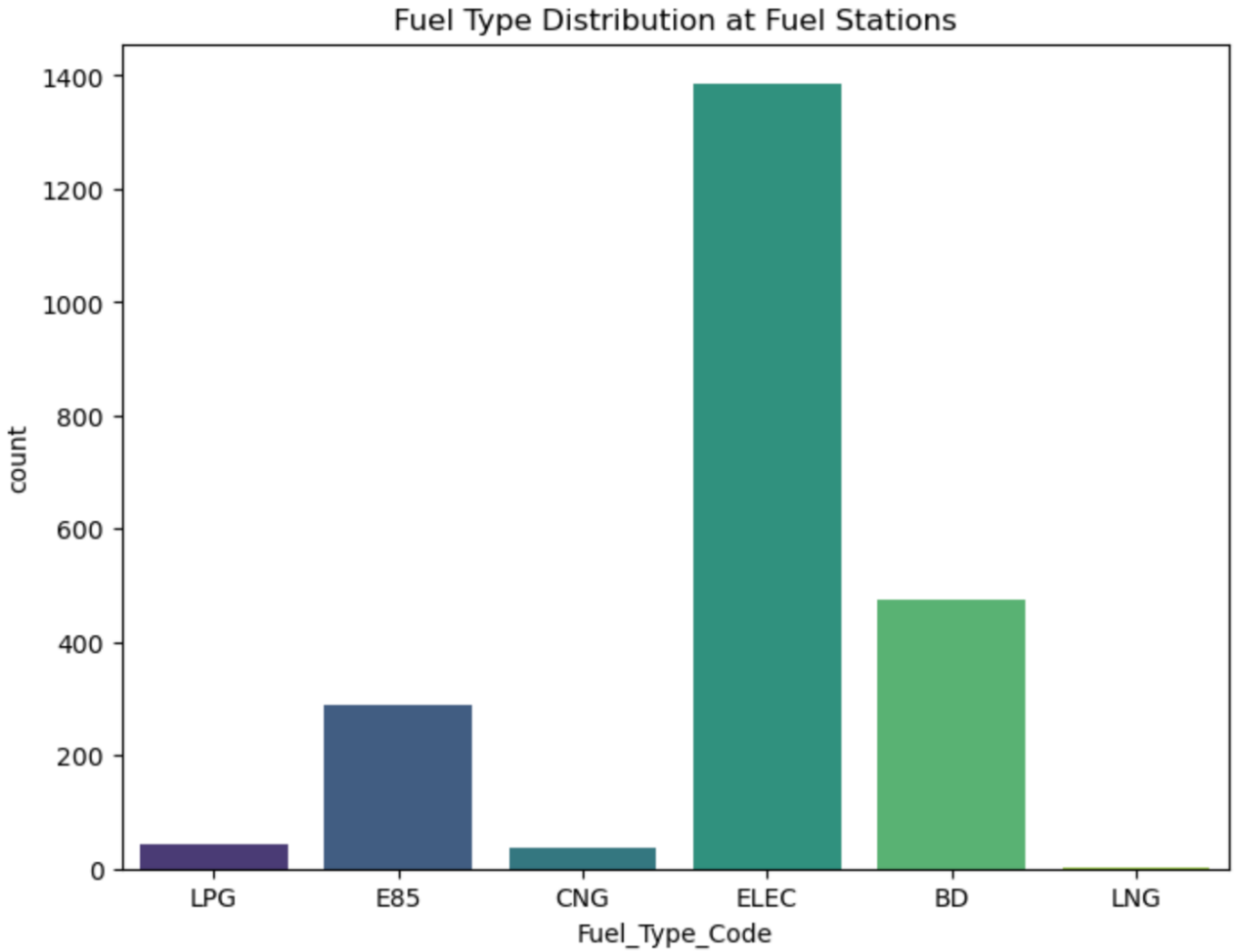
Results and Insights: (Continued)





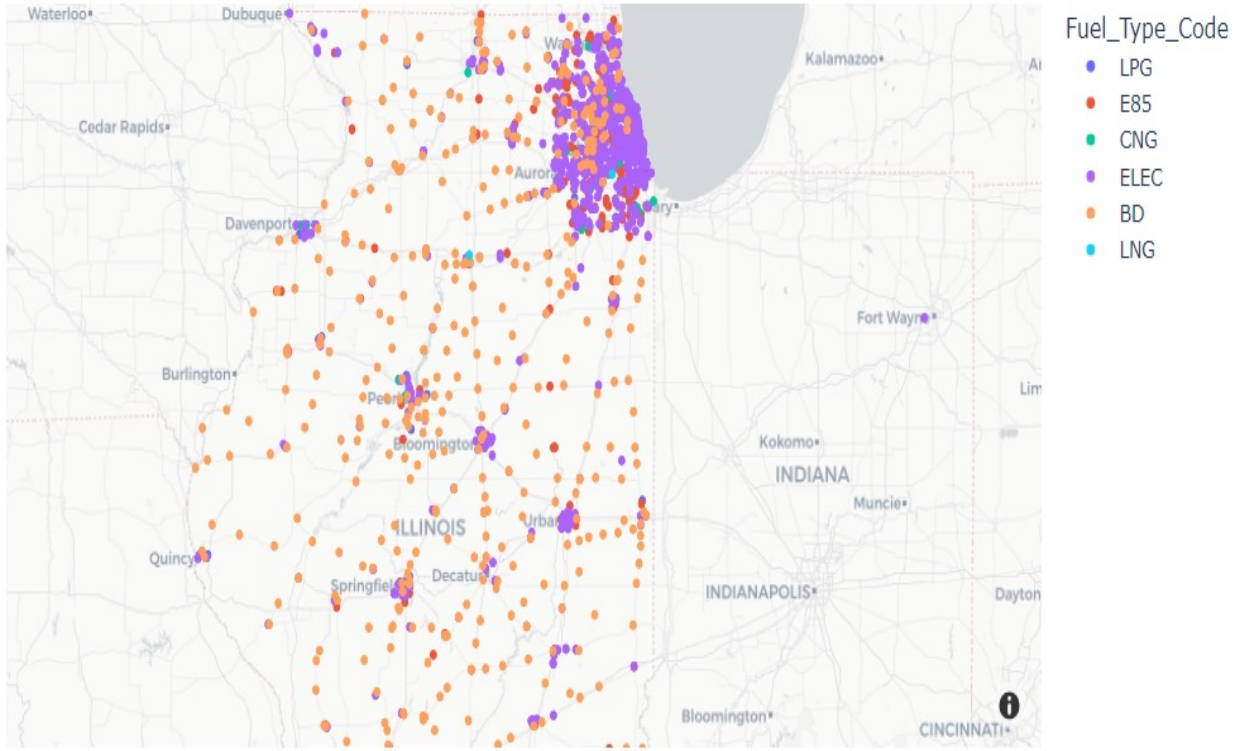
Results and Insights: (Continued)

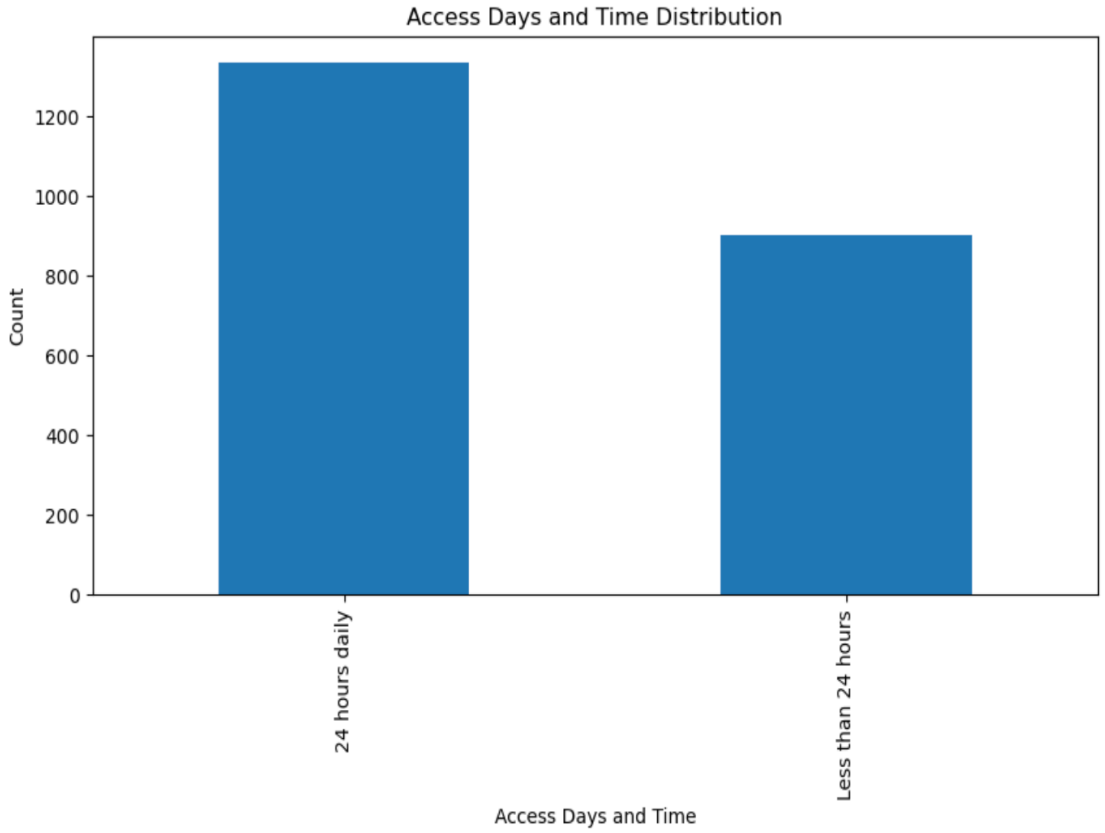




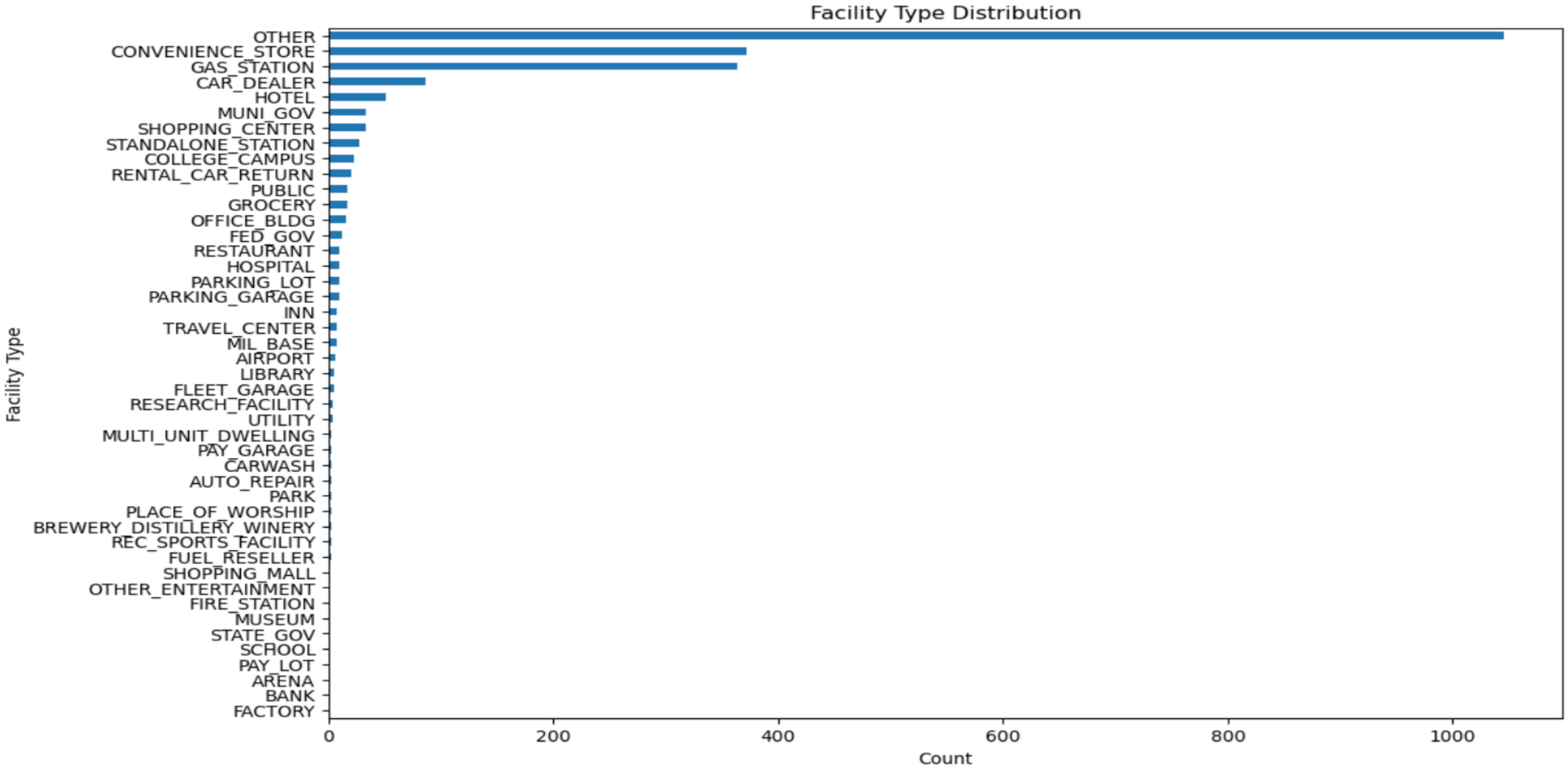
Results and Insights: (Continued)

Geospatial Distribution of Fuel Stations





Results and Insights:(Continued)



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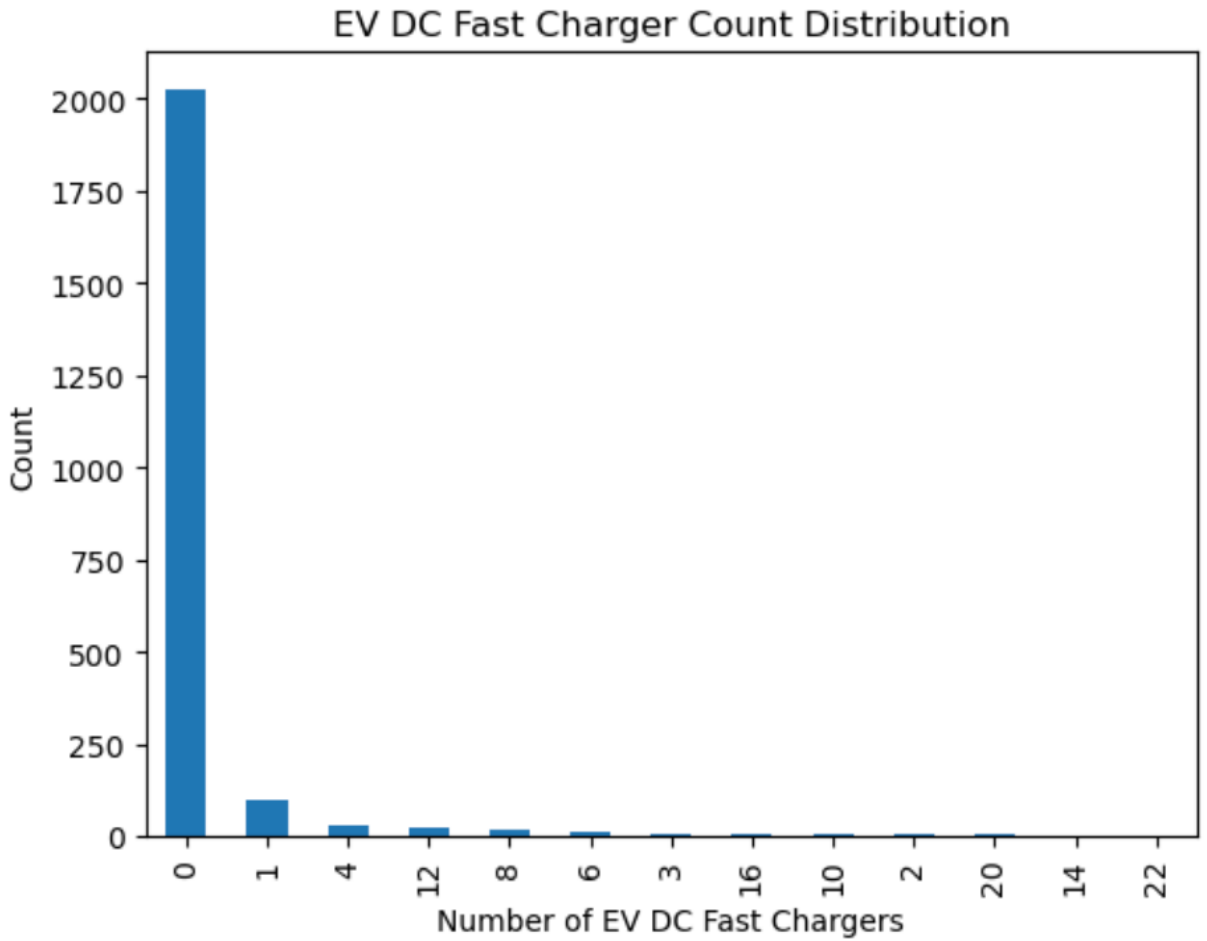

Conclusion:

The data cleaning and transformation efforts have successfully prepared the dataset for meaningful analysis.

Key accomplishments include:

- **Data Integrity**: Ensured data integrity by addressing missing values and applying consistent formatting.
- **Enhanced Readability**: Renaming columns for clarity and utilizing regex patterns improved the readability and interpretability of categorical data.
- **Standardized Time Information**: Normalized the representation of time information in the 'Access_Days_Time' column.
- **Improved Accessibility**: The transformation of credit card information into distinct columns facilitates a clear understanding of payment methods.
- **Standardized Naming**: Special character removal and value replacement enhanced the standardization of station names, contributing to a cleaner dataset.
- **Enhanced Phone Number Information**: Filled missing phone numbers, handled multiple entries, and replaced ambiguous values to ensure uniformity in the 'Station_Phone' column.