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Roll no:46 **Class:**D15C

EXPERIMENT NO: 1

Aim: Introduction to Data science and Data preparation using Pandas steps.

Theory:

Data preparation is a crucial step in data science, involving cleaning and transforming raw data into an analyzable format. Using Pandas, we can perform operations such as handling missing values, encoding categorical data, and scaling numerical features. Proper preprocessing ensures the dataset is reliable for analysis and modeling by addressing inconsistencies, missing data, and outliers.

Problem Statement:

The Vehicle Safety Recall dataset, provided by NHTSA, contains 15 columns detailing various aspects of recall events, such as manufacturers, affected components, and corrective actions. This analysis focuses on:

- **Manufacturer Trends**: Identifying manufacturers prone to frequent recalls or specific defects.
- **Impact Analysis**: Understanding recall types affecting the largest populations and assessing average completion rates.
- **Temporal Patterns**: Detecting trends in recalls over time and seasonal spikes.
- **Safety Implications**: Investigating critical safety advisories like "Do Not Drive" or "Park Outside" and their resolution rates.

By cleaning the dataset and applying data preprocessing steps, the goal is to enhance its quality and draw actionable insights for stakeholders.

Dataset Overview:

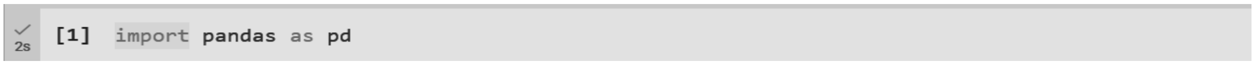
The dataset provides detailed information about vehicle safety recalls managed by the National Highway Traffic Safety Administration (NHTSA). It contains 15 columns, each capturing specific aspects of recall events. Below is a breakdown of the columns and their relevance:

1. **Report Received Date:** Date the recall was officially reported.
2. **NHTSA ID:** A unique identifier for each recall event.
3. **Recall Link:** A hyperlink to the recall details on the NHTSA website.
4. **Manufacturer:** Name of the vehicle or product manufacturer responsible for the recall.

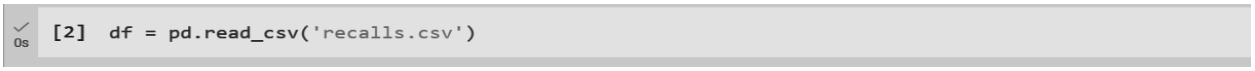
5. **Subject:** Brief description of the recall issue.
6. **Component:** The affected part of the vehicle/product (e.g., "POWER TRAIN").
7. **Mfr Campaign Number:** Manufacturer's internal reference for the recall.
8. **Recall Type:** Type of product involved (e.g., vehicle, tire, or car seat).
9. **Potentially Affected:** Number of units potentially impacted by the recall.
10. **Recall Description:** Detailed explanation of the defect or issue.
11. **Consequence Summary:** Description of the risks or consequences associated with the defect.
12. **Corrective Action:** Steps taken to address the defect.
13. **Park Outside Advisory:** Indicates whether there's an advisory to park outside for safety.
14. **Do Not Drive Advisory:** Indicates whether there's an advisory not to drive the affected vehicle.
15. **Completion Rate %:** Percentage of affected vehicles repaired or addressed.

Steps:

1. **Loading The Dataset**

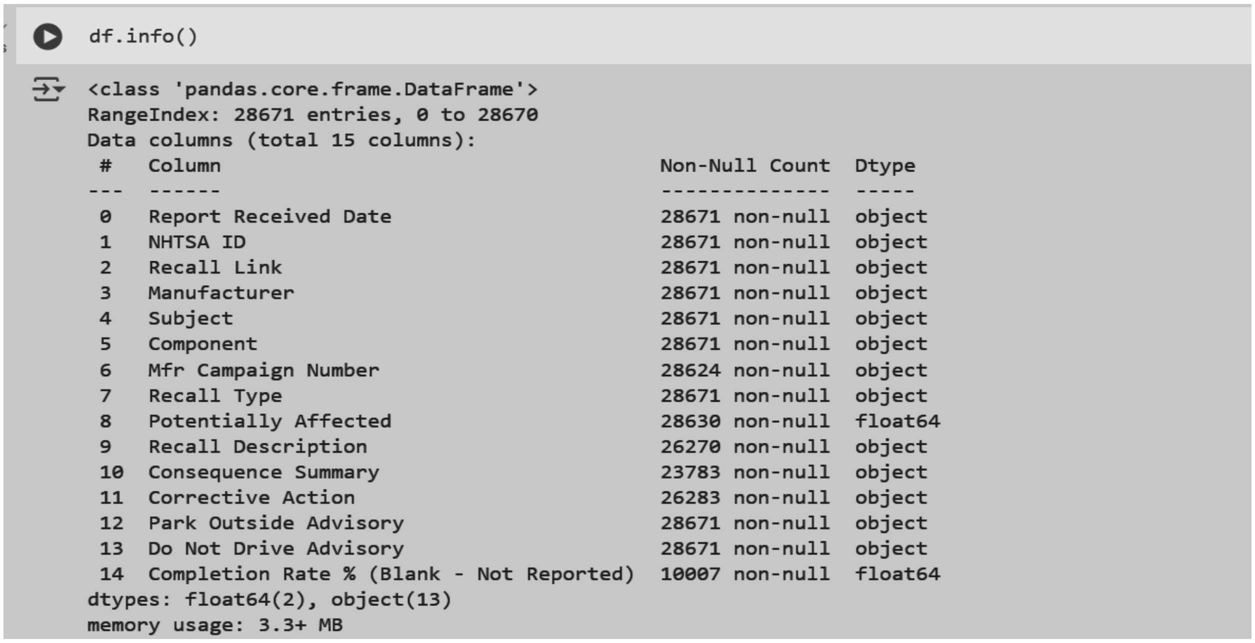


```
[1] import pandas as pd
```



```
[2] df = pd.read_csv('recalls.csv')
```

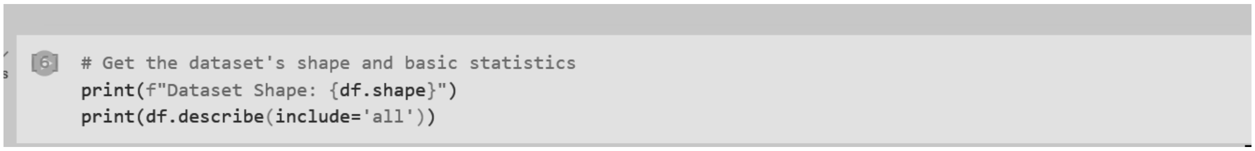
2. **Description of the dataset**
    a. **Information about dataset**



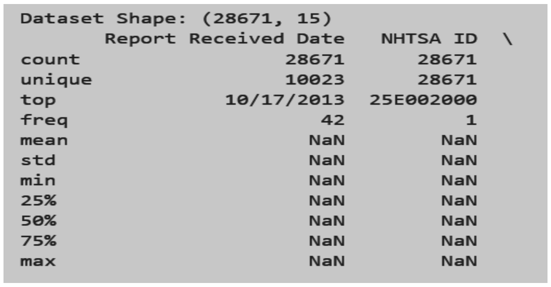
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 28671 entries, 0 to 28670
Data columns (total 15 columns):
 #   Column                                  Non-Null Count  Dtype
---  ------                                  --------------  -----
 0   Report Received Date                    28671 non-null  object
 1   NHTSA ID                                28671 non-null  object
 2   Recall Link                             28671 non-null  object
 3   Manufacturer                            28671 non-null  object
 4   Subject                                 28671 non-null  object
 5   Component                               28671 non-null  object
 6   Mfr Campaign Number                     28624 non-null  object
 7   Recall Type                             28671 non-null  object
 8   Potentially Affected                    28630 non-null  float64
 9   Recall Description                      26270 non-null  object
 10  Consequence Summary                     23783 non-null  object
 11  Corrective Action                       26283 non-null  object
 12  Park Outside Advisory                   28671 non-null  object
 13  Do Not Drive Advisory                   28671 non-null  object
 14  Completion Rate % (Blank - Not Reported)  10007 non-null  float64
dtypes: float64(2), object(13)
memory usage: 3.3+ MB
```

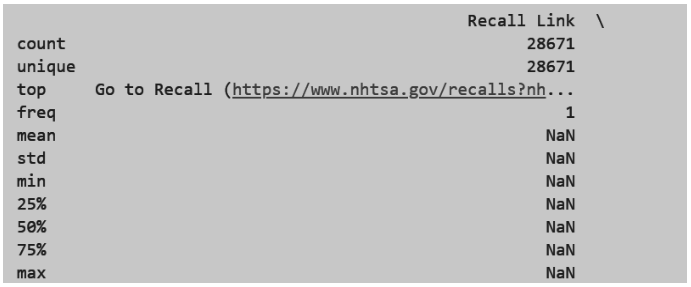
b. Description of Dataset



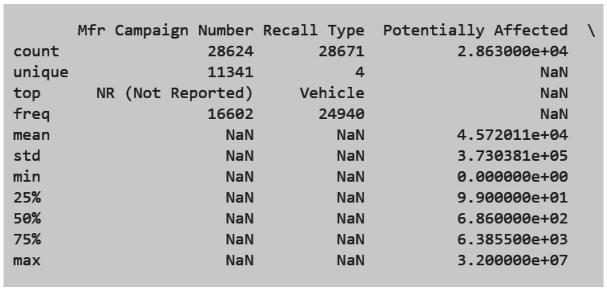
```
# Get the dataset's shape and basic statistics
print(f"Dataset Shape: {df.shape}")
print(df.describe(include='all'))
```



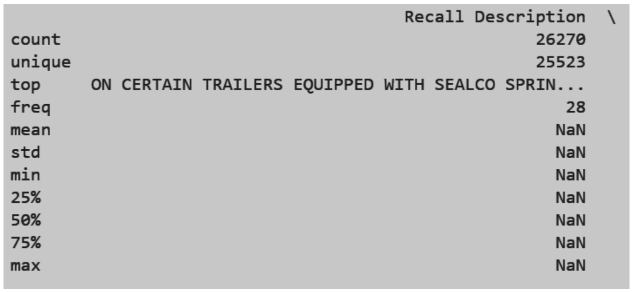
```
Dataset Shape: (28671, 15)
        Report Received Date   NHTSA ID  \
count                  28671      28671
unique                 10023      28671
top               10/17/2013  25E002000
freq                      42          1
mean                     NaN        NaN
std                      NaN        NaN
min                      NaN        NaN
25%                      NaN        NaN
50%                      NaN        NaN
75%                      NaN        NaN
max                      NaN        NaN
```



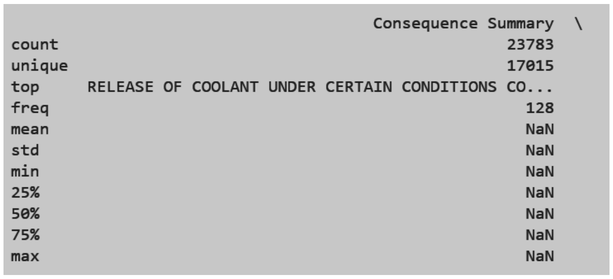
```
                                              Recall Link  \
count                                               28671
unique                                              28671
top     Go to Recall (https://www.nhtsa.gov/recalls?nh...
freq                                                    1
mean                                                  NaN
std                                                   NaN
min                                                   NaN
25%                                                   NaN
50%                                                   NaN
75%                                                   NaN
max                                                   NaN
```



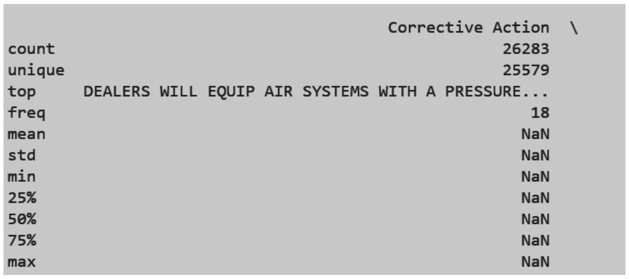
```
       Mfr Campaign Number Recall Type  Potentially Affected  \
count                28624       28671          2.863000e+04
unique               11341           4                   NaN
top      NR (Not Reported)     Vehicle                   NaN
freq                 16602       24940                   NaN
mean                   NaN         NaN          4.572011e+04
std                    NaN         NaN          3.730381e+05
min                    NaN         NaN          0.000000e+00
25%                    NaN         NaN          9.900000e+01
50%                    NaN         NaN          6.860000e+02
75%                    NaN         NaN          6.385500e+03
max                    NaN         NaN          3.200000e+07
```



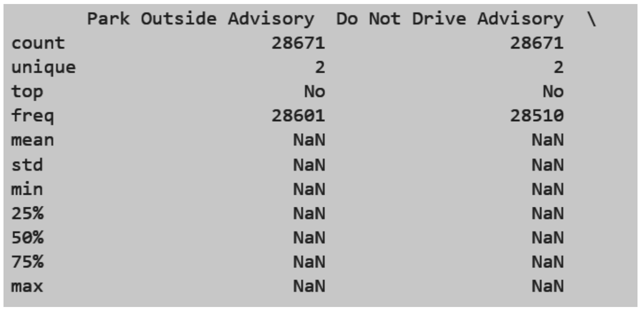
```
                                       Recall Description  \
count                                               26270
unique                                              25523
top     ON CERTAIN TRAILERS EQUIPPED WITH SEALCO SPRIN...
freq                                                   28
mean                                                  NaN
std                                                   NaN
min                                                   NaN
25%                                                   NaN
50%                                                   NaN
75%                                                   NaN
max                                                   NaN
```



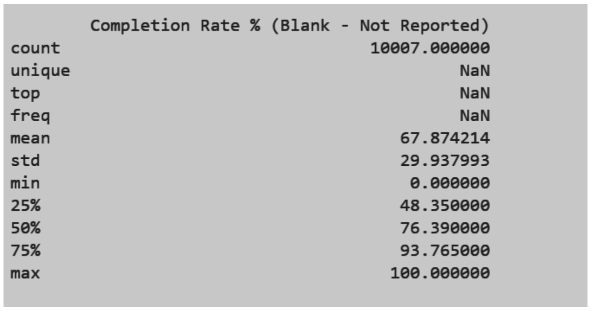
```
                                       Consequence Summary  \
count                                               23783
unique                                              17015
top     RELEASE OF COOLANT UNDER CERTAIN CONDITIONS CO...
freq                                                  128
mean                                                  NaN
std                                                   NaN
min                                                   NaN
25%                                                   NaN
50%                                                   NaN
75%                                                   NaN
max                                                   NaN
```



```
                                        Corrective Action  \
count                                               26283
unique                                              25579
top     DEALERS WILL EQUIP AIR SYSTEMS WITH A PRESSURE...
freq                                                   18
mean                                                  NaN
std                                                   NaN
min                                                   NaN
25%                                                   NaN
50%                                                   NaN
75%                                                   NaN
max                                                   NaN
```

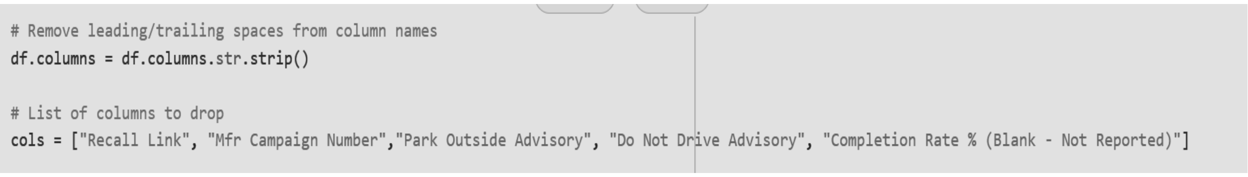


```
       Park Outside Advisory  Do Not Drive Advisory  \
count                  28671                  28671
unique                     2                      2
top                       No                     No
freq                   28601                  28510
mean                     NaN                    NaN
std                      NaN                    NaN
min                      NaN                    NaN
25%                      NaN                    NaN
50%                      NaN                    NaN
75%                      NaN                    NaN
max                      NaN                    NaN
```

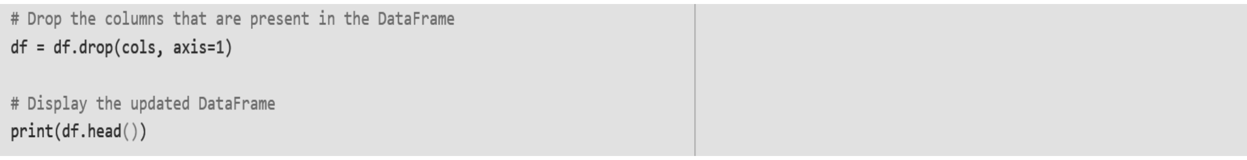


```
        Completion Rate % (Blank - Not Reported)
count                               10007.000000
unique                                       NaN
top                                          NaN
freq                                         NaN
mean                                   67.874214
std                                    29.937993
min                                     0.000000
25%                                    48.350000
50%                                    76.390000
75%                                    93.765000
max                                   100.000000
```

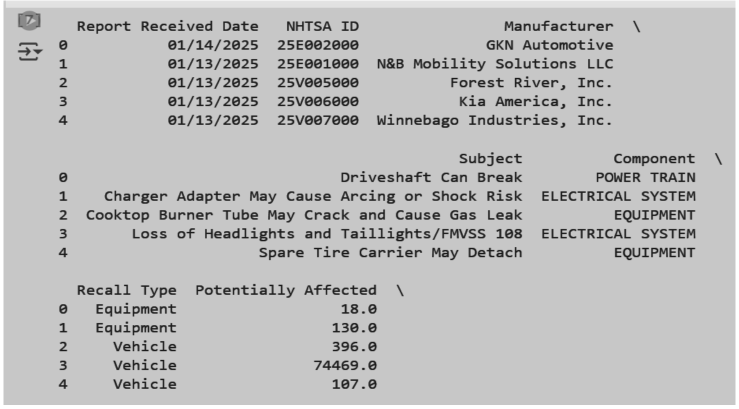
3. Drop columns that aren’t useful.



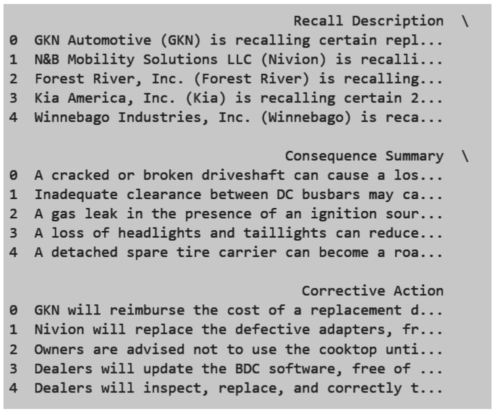
```
# Remove leading/trailing spaces from column names
df.columns = df.columns.str.strip()

# List of columns to drop
cols = ["Recall Link", "Mfr Campaign Number","Park Outside Advisory", "Do Not Drive Advisory", "Completion Rate % (Blank - Not Reported)"]
```



```
# Drop the columns that are present in the DataFrame
df = df.drop(cols, axis=1)

# Display the updated DataFrame
print(df.head())
```

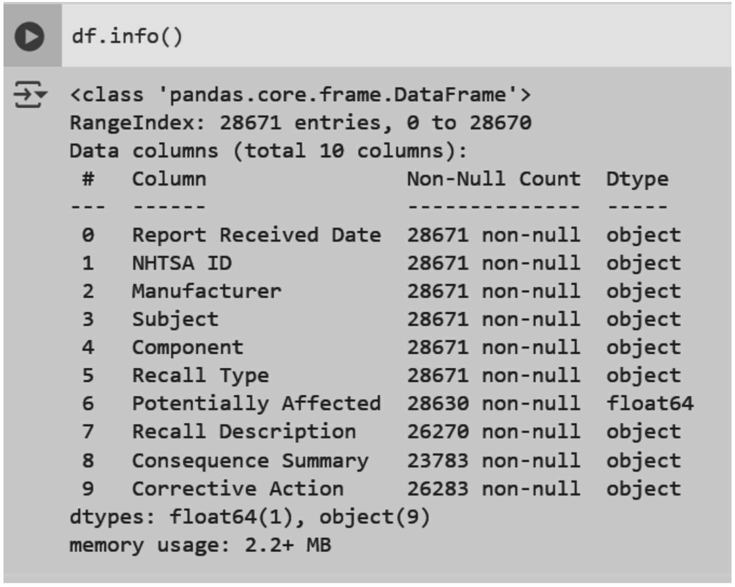


```
  Report Received Date   NHTSA ID              Manufacturer  \
0           01/14/2025  25E002000            GKN Automotive   
1           01/13/2025  25E001000  N&B Mobility Solutions LLC   
2           01/13/2025  25V005000        Forest River, Inc.   
3           01/13/2025  25V006000          Kia America, Inc.   
4           01/13/2025  25V007000  Winnebago Industries, Inc.   

                                         Subject          Component  \
0                           Driveshaft Can Break        POWER TRAIN   
1   Charger Adapter May Cause Arcing or Shock Risk  ELECTRICAL SYSTEM   
2  Cooktop Burner Tube May Crack and Cause Gas Leak          EQUIPMENT   
3     Loss of Headlights and Taillights/FMVSS 108  ELECTRICAL SYSTEM   
4                     Spare Tire Carrier May Detach          EQUIPMENT   

  Recall Type  Potentially Affected  \
0   Equipment                  18.0   
1   Equipment                 130.0   
2     Vehicle                 396.0   
3     Vehicle               74469.0   
4     Vehicle                 107.0   
```



```
                                  Recall Description  \
0  GKN Automotive (GKN) is recalling certain repl...   
1  N&B Mobility Solutions LLC (Nivion) is recalli...   
2  Forest River, Inc. (Forest River) is recalling...   
3  Kia America, Inc. (Kia) is recalling certain 2...   
4  Winnebago Industries, Inc. (Winnebago) is reca...   

                                 Consequence Summary  \
0  A cracked or broken driveshaft can cause a los...   
1  Inadequate clearance between DC busbars may ca...   
2  A gas leak in the presence of an ignition sour...   
3  A loss of headlights and taillights can reduce...   
4  A detached spare tire carrier can become a roa...   

                                   Corrective Action  
0  GKN will reimburse the cost of a replacement d...  
1  Nivion will replace the defective adapters, fr...  
2  Owners are advised not to use the cooktop unti...  
3  Dealers will update the BDC software, free of ...  
4  Dealers will inspect, replace, and correctly t...  
```

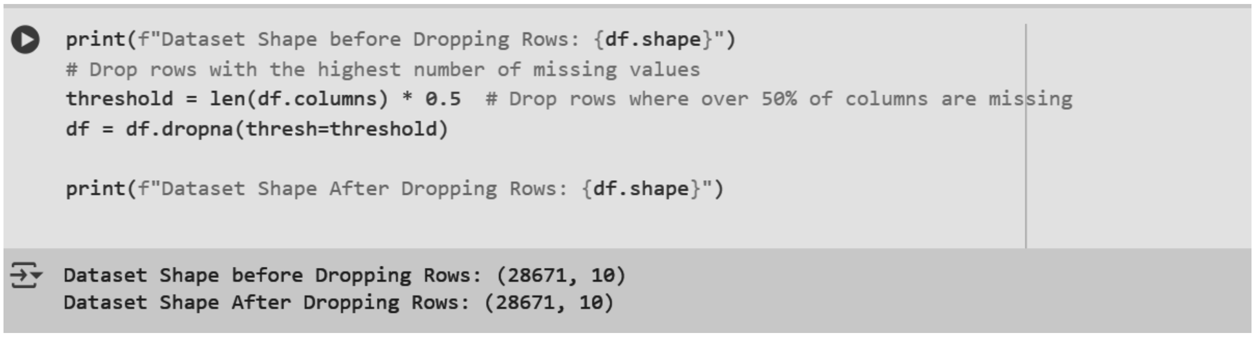
Thus the columns now present in dataset are:



```
df.info()
```

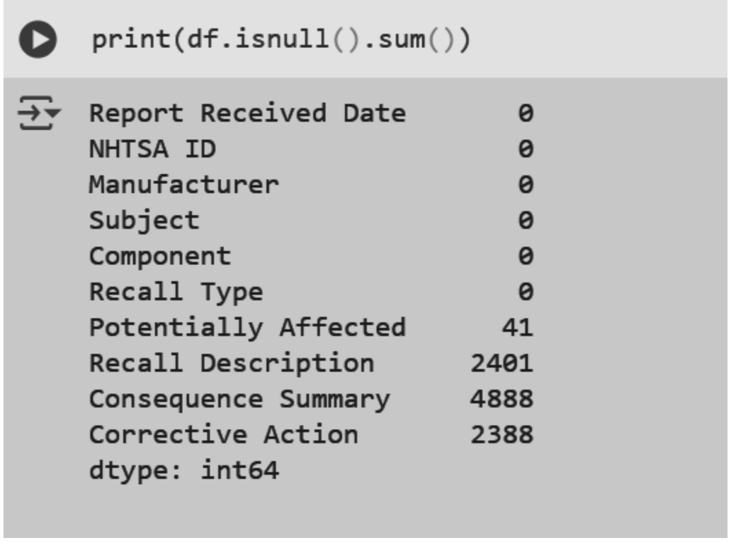
```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 28671 entries, 0 to 28670
Data columns (total 10 columns):
 #   Column                Non-Null Count  Dtype  
---  ------                --------------  -----  
 0   Report Received Date  28671 non-null  object 
 1   NHTSA ID              28671 non-null  object 
 2   Manufacturer          28671 non-null  object 
 3   Subject               28671 non-null  object 
 4   Component             28671 non-null  object 
 5   Recall Type           28671 non-null  object 
 6   Potentially Affected  28630 non-null  float64
 7   Recall Description    26270 non-null  object 
 8   Consequence Summary   23783 non-null  object 
 9   Corrective Action     26283 non-null  object 
dtypes: float64(1), object(9)
memory usage: 2.2+ MB
```

4. **Take care of missing data.**
    a. **Drop rows with maximum missing values.**



```
print(f"Dataset Shape before Dropping Rows: {df.shape}")
# Drop rows with the highest number of missing values
threshold = len(df.columns) * 0.5  # Drop rows where over 50% of columns are missing
df = df.dropna(thresh=threshold)

print(f"Dataset Shape After Dropping Rows: {df.shape}")
```

```
Dataset Shape before Dropping Rows: (28671, 10)
Dataset Shape After Dropping Rows: (28671, 10)
```

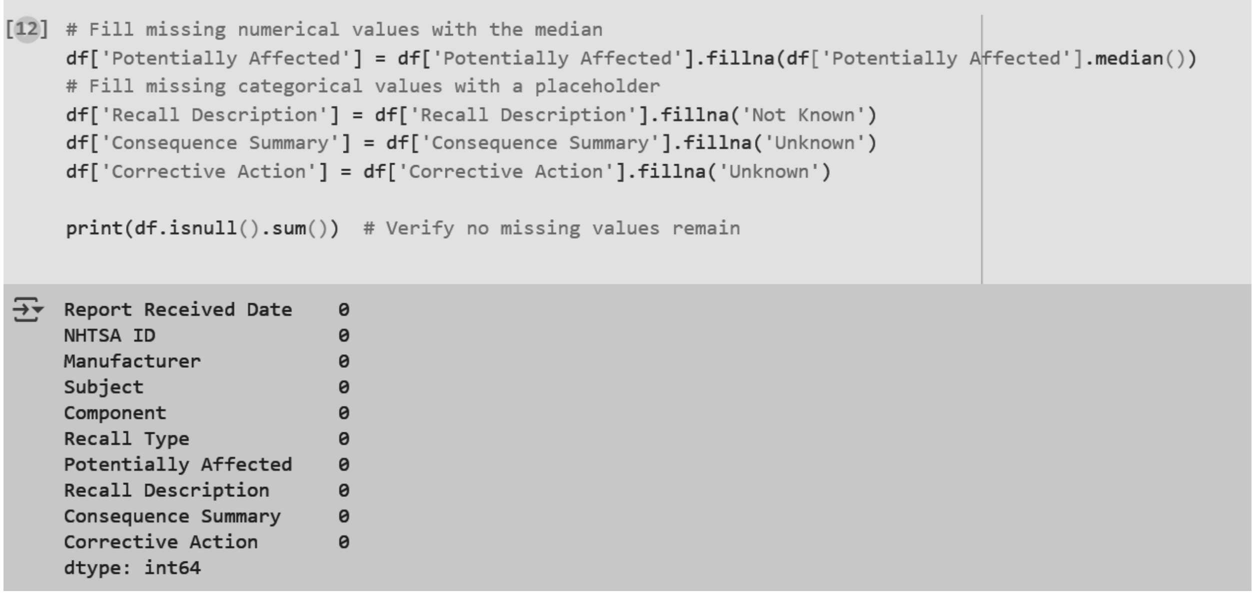


```
print(df.isnull().sum())
```

```
Report Received Date       0
NHTSA ID                   0
Manufacturer               0
Subject                    0
Component                  0
Recall Type                0
Potentially Affected      41
Recall Description      2401
Consequence Summary     4888
Corrective Action       2388
dtype: int64
```

b. Handle Missing Data

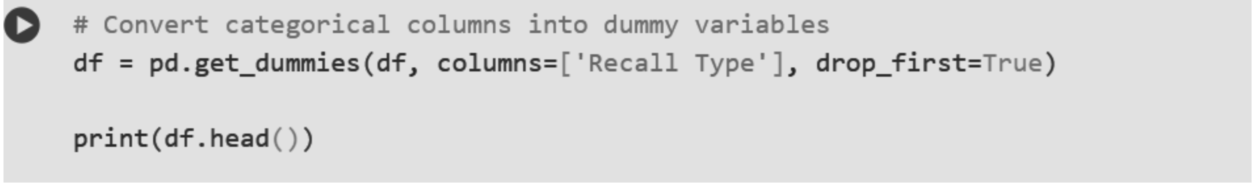
Here above info says Potential Affected ,Recall Description ,Consequence Summary and corrective action contain some null values thus we need to handle missing data.



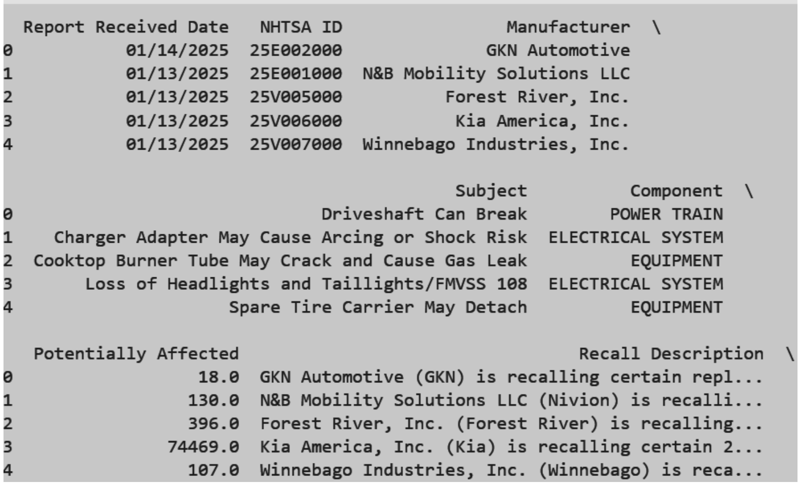
```
[12] # Fill missing numerical values with the median
     df['Potentially Affected'] = df['Potentially Affected'].fillna(df['Potentially Affected'].median())
     # Fill missing categorical values with a placeholder
     df['Recall Description'] = df['Recall Description'].fillna('Not Known')
     df['Consequence Summary'] = df['Consequence Summary'].fillna('Unknown')
     df['Corrective Action'] = df['Corrective Action'].fillna('Unknown')

     print(df.isnull().sum())  # Verify no missing values remain
```

```
Report Received Date    0
NHTSA ID                0
Manufacturer            0
Subject                 0
Component               0
Recall Type             0
Potentially Affected    0
Recall Description      0
Consequence Summary     0
Corrective Action       0
dtype: int64
```

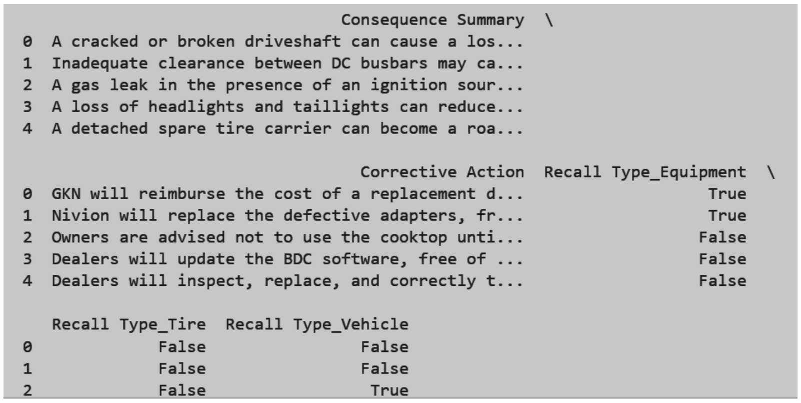
5. Create dummy variables



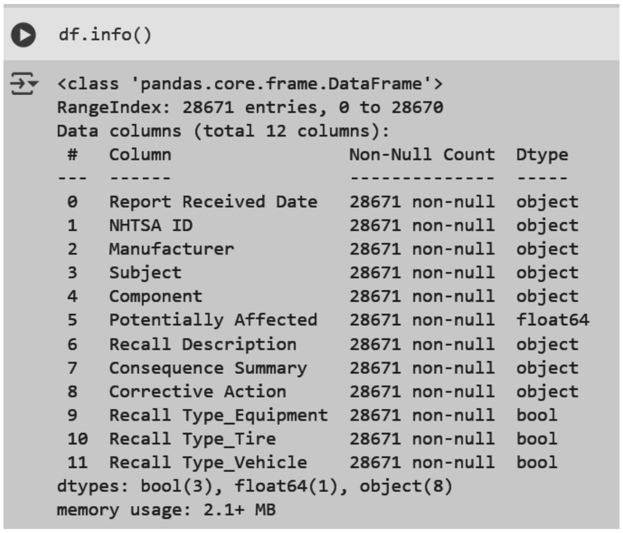
```
# Convert categorical columns into dummy variables
df = pd.get_dummies(df, columns=['Recall Type'], drop_first=True)

print(df.head())
```



```
  Report Received Date   NHTSA ID                Manufacturer  \
0           01/14/2025  25E002000              GKN Automotive   
1           01/13/2025  25E001000  N&B Mobility Solutions LLC   
2           01/13/2025  25V005000          Forest River, Inc.   
3           01/13/2025  25V006000           Kia America, Inc.   
4           01/13/2025  25V007000  Winnebago Industries, Inc.   

                                            Subject          Component  \
0                              Driveshaft Can Break        POWER TRAIN   
1    Charger Adapter May Cause Arcing or Shock Risk  ELECTRICAL SYSTEM   
2  Cooktop Burner Tube May Crack and Cause Gas Leak          EQUIPMENT   
3       Loss of Headlights and Taillights/FMVSS 108  ELECTRICAL SYSTEM   
4                     Spare Tire Carrier May Detach          EQUIPMENT   

   Potentially Affected                                 Recall Description  \
0                  18.0  GKN Automotive (GKN) is recalling certain repl...   
1                 130.0  N&B Mobility Solutions LLC (Nivion) is recalli...   
2                 396.0  Forest River, Inc. (Forest River) is recalling...   
3               74469.0  Kia America, Inc. (Kia) is recalling certain 2...   
4                 107.0  Winnebago Industries, Inc. (Winnebago) is reca...   
```



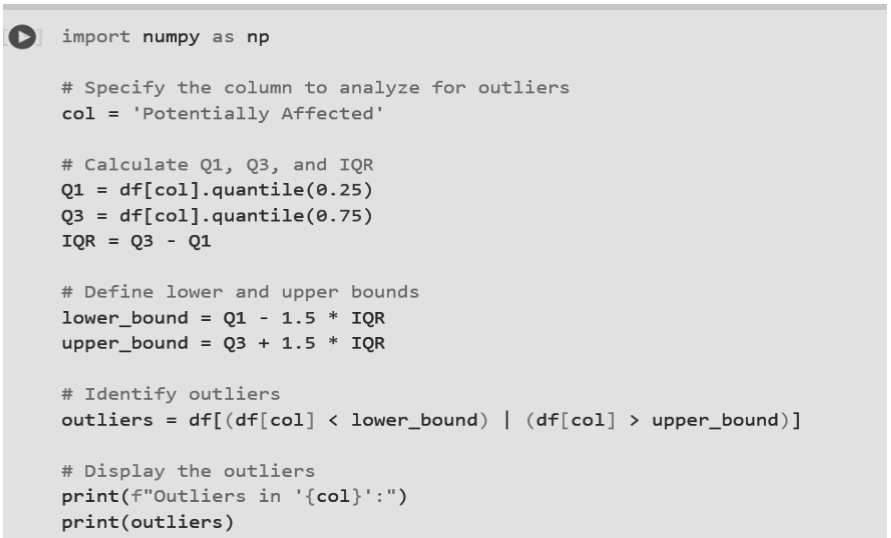
```
                                 Consequence Summary  \
0  A cracked or broken driveshaft can cause a los...   
1  Inadequate clearance between DC busbars may ca...   
2  A gas leak in the presence of an ignition sour...   
3  A loss of headlights and taillights can reduce...   
4  A detached spare tire carrier can become a roa...   

                                   Corrective Action  Recall Type_Equipment  \
0  GKN will reimburse the cost of a replacement d...                   True   
1  Nivion will replace the defective adapters, fr...                   True   
2  Owners are advised not to use the cooktop unti...                  False   
3  Dealers will update the BDC software, free of ...                  False   
4  Dealers will inspect, replace, and correctly t...                  False   

   Recall Type_Tire  Recall Type_Vehicle  
0             False                False  
1             False                False  
2             False                 True  
```



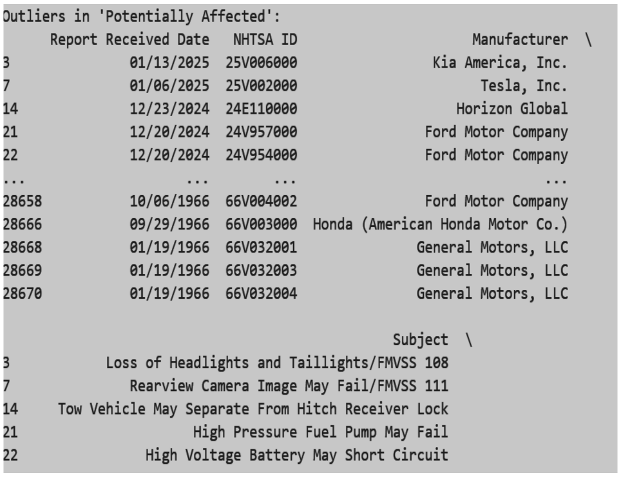
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 28671 entries, 0 to 28670
Data columns (total 12 columns):
 #   Column                 Non-Null Count  Dtype  
---  ------                 --------------  -----  
 0   Report Received Date   28671 non-null  object 
 1   NHTSA ID               28671 non-null  object 
 2   Manufacturer           28671 non-null  object 
 3   Subject                28671 non-null  object 
 4   Component              28671 non-null  object 
 5   Potentially Affected   28671 non-null  float64
 6   Recall Description     28671 non-null  object 
 7   Consequence Summary    28671 non-null  object 
 8   Corrective Action      28671 non-null  object 
 9   Recall Type_Equipment  28671 non-null  bool   
 10  Recall Type_Tire       28671 non-null  bool   
 11  Recall Type_Vehicle    28671 non-null  bool   
dtypes: bool(3), float64(1), object(8)
memory usage: 2.1+ MB
```

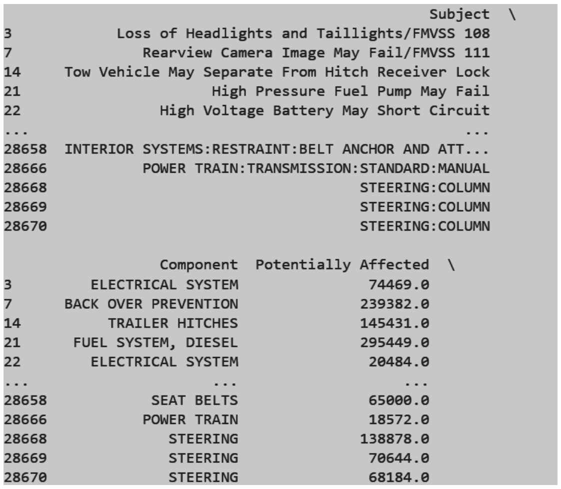
6. Find out outliers (manually)



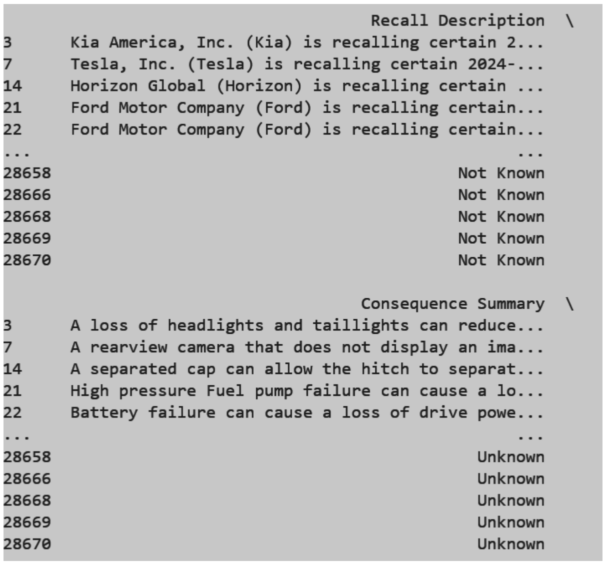
```python
import numpy as np

# Specify the column to analyze for outliers
col = 'Potentially Affected'

# Calculate Q1, Q3, and IQR
Q1 = df[col].quantile(0.25)
Q3 = df[col].quantile(0.75)
IQR = Q3 - Q1

# Define lower and upper bounds
lower_bound = Q1 - 1.5 * IQR
upper_bound = Q3 + 1.5 * IQR

# Identify outliers
outliers = df[(df[col] < lower_bound) | (df[col] > upper_bound)]

# Display the outliers
print(f"Outliers in '{col}':")
print(outliers)
```



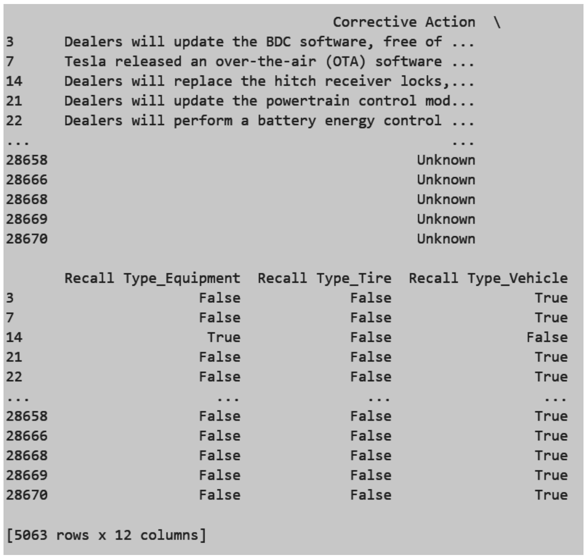
```
Outliers in 'Potentially Affected':
      Report Received Date   NHTSA ID                        Manufacturer  \
3               01/13/2025  25V006000                  Kia America, Inc.
7               01/06/2025  25V002000                       Tesla, Inc.
14              12/23/2024  24E110000                     Horizon Global
21              12/20/2024  24V957000                 Ford Motor Company
22              12/20/2024  24V954000                 Ford Motor Company
...                    ...        ...                                ...
28658           10/06/1966  66V004002                 Ford Motor Company
28666           09/29/1966  66V003000  Honda (American Honda Motor Co.)
28668           01/19/1966  66V032001               General Motors, LLC
28669           01/19/1966  66V032003               General Motors, LLC
28670           01/19/1966  66V032004               General Motors, LLC

                                         Subject  \
3           Loss of Headlights and Taillights/FMVSS 108
7             Rearview Camera Image May Fail/FMVSS 111
14    Tow Vehicle May Separate From Hitch Receiver Lock
21                     High Pressure Fuel Pump May Fail
22                 High Voltage Battery May Short Circuit
```



```
                                                 Subject  \
3             Loss of Headlights and Taillights/FMVSS 108
7               Rearview Camera Image May Fail/FMVSS 111
14      Tow Vehicle May Separate From Hitch Receiver Lock
21                       High Pressure Fuel Pump May Fail
22                   High Voltage Battery May Short Circuit
...                                                   ...
28658  INTERIOR SYSTEMS:RESTRAINT:BELT ANCHOR AND ATT...
28666          POWER TRAIN:TRANSMISSION:STANDARD:MANUAL
28668                                   STEERING:COLUMN
28669                                   STEERING:COLUMN
28670                                   STEERING:COLUMN

                 Component  Potentially Affected  \
3         ELECTRICAL SYSTEM               74469.0
7       BACK OVER PREVENTION             239382.0
14          TRAILER HITCHES              145431.0
21      FUEL SYSTEM, DIESEL              295449.0
22        ELECTRICAL SYSTEM               20484.0
...                     ...                   ...
28658            SEAT BELTS               65000.0
28666           POWER TRAIN               18572.0
28668              STEERING              138878.0
28669              STEERING               70644.0
28670              STEERING               68184.0
```

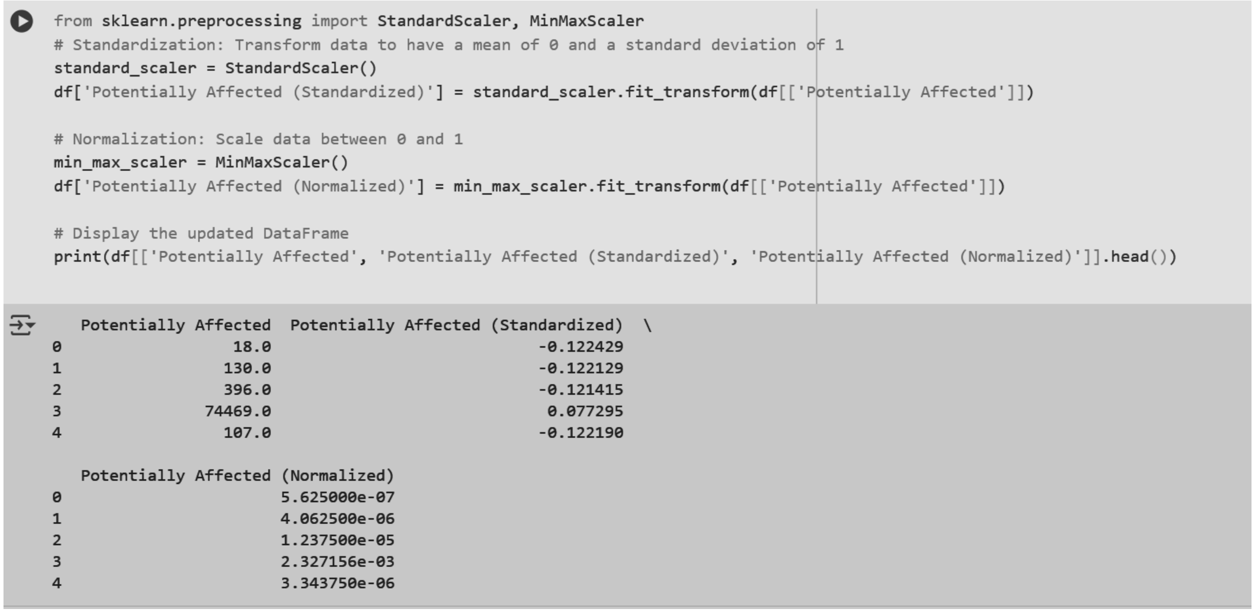


```
                                    Recall Description  \
3      Kia America, Inc. (Kia) is recalling certain 2...
7      Tesla, Inc. (Tesla) is recalling certain 2024-...
14     Horizon Global (Horizon) is recalling certain ...
21     Ford Motor Company (Ford) is recalling certain...
22     Ford Motor Company (Ford) is recalling certain...
...                                                  ...
28658                                          Not Known
28666                                          Not Known
28668                                          Not Known
28669                                          Not Known
28670                                          Not Known

                                    Consequence Summary  \
3      A loss of headlights and taillights can reduce...
7      A rearview camera that does not display an ima...
14     A separated cap can allow the hitch to separat...
21     High pressure Fuel pump failure can cause a lo...
22     Battery failure can cause a loss of drive powe...
...                                                  ...
28658                                            Unknown
28666                                            Unknown
28668                                            Unknown
28669                                            Unknown
28670                                            Unknown
```



```
                                       Corrective Action  \
3      Dealers will update the BDC software, free of ...
7      Tesla released an over-the-air (OTA) software ...
14     Dealers will replace the hitch receiver locks,...
21     Dealers will update the powertrain control mod...
22     Dealers will perform a battery energy control ...
...                                                  ...
28658                                            Unknown
28666                                            Unknown
28668                                            Unknown
28669                                            Unknown
28670                                            Unknown

      Recall Type_Equipment  Recall Type_Tire  Recall Type_Vehicle
3                     False             False                 True
7                     False             False                 True
14                     True             False                False
21                    False             False                 True
22                    False             False                 True
...                     ...               ...                  ...
28658                 False             False                 True
28666                 False             False                 True
28668                 False             False                 True
28669                 False             False                 True
28670                 False             False                 True

[5063 rows x 12 columns]
```

7. standardization and normalization of column



```
from sklearn.preprocessing import StandardScaler, MinMaxScaler
# Standardization: Transform data to have a mean of 0 and a standard deviation of 1
standard_scaler = StandardScaler()
df['Potentially Affected (Standardized)'] = standard_scaler.fit_transform(df[['Potentially Affected']])

# Normalization: Scale data between 0 and 1
min_max_scaler = MinMaxScaler()
df['Potentially Affected (Normalized)'] = min_max_scaler.fit_transform(df[['Potentially Affected']])

# Display the updated DataFrame
print(df[['Potentially Affected', 'Potentially Affected (Standardized)', 'Potentially Affected (Normalized)']].head())
```

```
   Potentially Affected  Potentially Affected (Standardized)  \
0                  18.0                             -0.122429
1                 130.0                             -0.122129
2                 396.0                             -0.121415
3               74469.0                              0.077295
4                 107.0                             -0.122190

   Potentially Affected (Normalized)
0                       5.625000e-07
1                       4.062500e-06
2                       1.237500e-05
3                       2.327156e-03
4                       3.343750e-06
```

Conclusion:

This experiment demonstrated effective data cleaning and preparation techniques. Issues such as missing values, irrelevant data, and outliers were addressed, and the dataset was scaled for uniformity. These steps are essential for ensuring high-quality data and reliable model outcomes.