| | |
|---|---|
| Project Title | **Electric Vehicle Sales by State in India** |
| Tools | Python, ML, SQL, Excel |
| Domain | Data Analyst |
| Project Difficulties level | intermediate |

Dataset : Dataset is available in the given link. You can download it at your convenience.

Click here to download data set

**About Dataset**

This dataset is valuable for analysts, data scientists, and researchers aiming to understand electric vehicle (EV) adoption trends across India. It is versatile and ideal for geographic market segmentation, trend analysis, and predictive modeling. By offering insights into regional EV sales patterns, the dataset supports strategic decision-making in market planning and infrastructure investment.

The data was meticulously scraped from the Clean Mobility Shift website, and then thoroughly preprocessed to ensure accuracy and relevance. All null values have been removed, and the dataset has been cleaned to prepare it for immediate use in exploration, visualization, and analytical projects. It is particularly valuable for market trend analysis, infrastructure planning, and policy development within the EV sector. The dataset is provided in CSV format and is ready for analysis.

Included Files:

EV_Dataset.csv: Contains state-level data on EV sales, including vehicle types and categories, offering a comprehensive view of EV distribution across Indian states.

Key Features:

State: Names of Indian states with recorded EV sales data.

Vehicle Type: Classifications of vehicles, such as two-wheelers and four-wheelers.

Vehicle Category: Further classification into segments like commercial and passenger vehicles.

Electric_Vehicle_Sales_Quantity: The number of EVs sold per state, essential for analyzing adoption trends.

**Example: You can get the basic idea how you can create a project from here**

**Electric Vehicle Sales by State in India: Machine Learning Project (3-Year Experience Level)**

This project aims to analyze and predict the sales of Electric Vehicles (EV) by state in India using machine learning. The dataset contains the following columns:

- **Year**: The year of the sales.
- **Month_Name**: The month in which sales occurred.
- **Date**: The specific date of the sales.
- **State**: The state in India where the sales occurred.
- **Vehicle_Class**: The class of the vehicle (e.g., sedan, SUV, etc.).
- **Vehicle_Category**: The category of the vehicle (e.g., commercial, passenger).
- **Vehicle_Type**: The type of the vehicle (e.g., 2-wheeler, 4-wheeler).
- **EV_Sales_Quantity**: The quantity of EV sales.

**Steps Involved:**

1. **Data Collection**: Load and inspect the dataset.

2. **Data Preprocessing**: Handle missing values, convert date formats, and perform feature engineering.
3. **Exploratory Data Analysis (EDA)**: Visualize trends and relationships between variables.
4. **Feature Engineering**: Create new features from the date column and encode categorical variables.
5. **Modeling**: Build a regression model to predict EV sales.
6. **Evaluation**: Evaluate the model performance and interpret the results.
7. **Visualization**: Visualize the results and trends using graphs and charts.

**Python Code: Step-by-Step**

**Step 1: Data Collection**

Start by loading the dataset. For this example, let's assume the dataset is in CSV format.

```
# Import necessary libraries
import pandas as pd
import numpy as np

# Load the dataset
df = pd.read_csv('ev_sales_india.csv')

# Display the first few rows of the dataset
print(df.head())
```

**Step 2: Data Preprocessing**

Handle missing values and convert the date column to a proper datetime format.

```
# Convert 'Date' column to datetime format
df['Date'] = pd.to_datetime(df['Date'])

# Check for missing values
print(df.isnull().sum())

# Fill missing values (if any) using median for numerical
columns or mode for categorical columns
df['EV_Sales_Quantity'].fillna(df['EV_Sales_Quantity'].median()
, inplace=True)
df.fillna(df.mode().iloc[0], inplace=True)
```

**Step 3: Exploratory Data Analysis (EDA)**

Visualize trends in EV sales over time, across states, and vehicle categories.

```
import matplotlib.pyplot as plt
import seaborn as sns

# Plot EV sales over the years
plt.figure(figsize=(10, 6))
sns.lineplot(data=df, x='Year', y='EV_Sales_Quantity',
hue='State')
plt.title('EV Sales by State over the Years')
plt.show()

# Plot sales by vehicle category
```

```
plt.figure(figsize=(10, 6))
sns.barplot(x='Vehicle_Category', y='EV_Sales_Quantity',
data=df, ci=None)
plt.title('EV Sales by Vehicle Category')
plt.show()
```

**Step 4: Feature Engineering**

Create new features such as month and day from the `Date` column and encode categorical variables.

```
# Extract Month and Day from the Date column
df['Month'] = df['Date'].dt.month
df['Day'] = df['Date'].dt.day

# Encode categorical variables using one-hot encoding
df_encoded = pd.get_dummies(df, columns=['State',
'Vehicle_Class', 'Vehicle_Category', 'Vehicle_Type'],
drop_first=True)

# Drop unnecessary columns like Date, Month_Name (if already
extracted into numerical values)
df_encoded.drop(['Date', 'Month_Name'], axis=1, inplace=True)
```

**Step 5: Modeling**

Use a regression model (e.g., Random Forest Regressor) to predict EV sales.

```
from sklearn.model_selection import train_test_split
from sklearn.ensemble import RandomForestRegressor
from sklearn.metrics import mean_squared_error

# Split the data into features and target variable
X = df_encoded.drop('EV_Sales_Quantity', axis=1)
y = df_encoded['EV_Sales_Quantity']

# Split the dataset into training and testing sets
X_train, X_test, y_train, y_test = train_test_split(X, y,
test_size=0.2, random_state=42)

# Instantiate the model
model = RandomForestRegressor(n_estimators=100,
random_state=42)

# Train the model
model.fit(X_train, y_train)

# Make predictions
y_pred = model.predict(X_test)

# Evaluate the model
mse = mean_squared_error(y_test, y_pred)
rmse = np.sqrt(mse)
```

```
print(f'Root Mean Squared Error: {rmse}')
```

**Step 6: Model Evaluation**

Check how well the model performs on the test set.

```
# Plot actual vs predicted sales
plt.figure(figsize=(10, 6))
plt.scatter(y_test, y_pred)
plt.title('Actual vs Predicted EV Sales')
plt.xlabel('Actual EV Sales')
plt.ylabel('Predicted EV Sales')
plt.show()

# Check feature importance
importance = model.feature_importances_
feature_importance = pd.Series(importance,
index=X_train.columns).sort_values(ascending=False)

# Plot the most important features
plt.figure(figsize=(10, 6))
feature_importance.plot(kind='bar')
plt.title('Feature Importance')
plt.show()
```

**Step 7: Conclusion**

The machine learning model helps in understanding the factors affecting Electric

Vehicle sales across different states and predicting future sales based on historical data. Feature importance gives insight into which factors (e.g., State, Vehicle Category) have the highest impact on sales.

**Explanation:**

- **Data Preprocessing**: Cleaned the dataset and handled missing values.
- **Feature Engineering**: Created new columns from the `Date` column and encoded categorical variables.
- **Modeling**: Built a Random Forest Regressor model to predict EV sales and evaluated its performance using RMSE (Root Mean Squared Error).
- **Visualization**: Visualized sales trends and feature importance using bar plots and scatter plots.

**NOTE :**

**1. this project is only for your guidance, not exactly the same you have to create. Here I am trying to show the way or idea of what steps you can follow and how your projects look. Some projects are very advanced (because it will be made with the help of flask, nlp, advance ai, advance DL and some advanced things ) which you can not understand .**

**2. You can make or analyze your project with yourself, with your idea, make it more creative from where we can get some information and understand about our business. make sure what overall things you have created all things you understand very well.**

**Example: You can get the basic idea how you can create a project from here**

**Sample code with output**

Importing all the Required Libraries.¶

In [1]:

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
```

Reading the Given Dataset as a Pandas Dataframe.

In [2]:

```
df=pd.read_csv('EV_Dataset.csv')
```

Basic Dataset Overview

In [3]:

```
df.shape # so the data contains 96845 rows and 8 columns.
```

Out[3]:

```
(96845, 8)
```

In [4]:

```
df.columns.nunique() # 8 unique columns are present in total.
```

Out[4]:

```
8
```

In [5]:

```
df.columns # column names are as below:
```

```
Out[5]:
Index(['Year', 'Month_Name', 'Date', 'State', 'Vehicle_Class',
       'Vehicle_Category', 'Vehicle_Type',
'EV_Sales_Quantity'],
      dtype='object')
In [6]:
df.head() # first 5 rows of the dataset.
```

Out[6]:

| | Year | Month_Name | Date | State | Vehicle_Class | Vehicle_Category | Vehicle_Type | EV_Sales_Quantity |
|---|---|---|---|---|---|---|---|---|
| 0 | 2014.0 | jan | 1/1/2014 | Andhra Pradesh | ADAPTED VEHICLE | Others | Others | 0.0 |
| 1 | 2014.0 | jan | 1/1/2014 | Andhra Pradesh | AGRICULTURAL TRACTOR | Others | Others | 0.0 |
| 2 | 2014.0 | jan | 1/1/2014 | Andhra Pradesh | AMBULANCE | Others | Others | 0.0 |
| 3 | 2014.0 | jan | 1/1/2014 | Andhra Pradesh | ARTICULATED VEHICLE | Others | Others | 0.0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 4 | 2014.0 | jan | 1/1/2014 | Andhra Pradesh | BUS | Bus | Bus | 0.0 |

In [7]:

```
df.tail() # last 5 rows of the dataset.
```

Out[7]:

| | Year | Month_Name | Date | State | Vehicle_Class | Vehicle_Category | Vehicle_Type | EV_Sales_Quantity |
|---|---|---|---|---|---|---|---|---|
| 96840 | 2023.0 | dec | 12/1/2023 | Andaman & Nicobar Island | MOTOR CAR | 4-Wheelers | 4W_Personal | 1.0 |
| 96841 | 2023.0 | dec | 12/1/2023 | Andaman & Nicobar Island | MOTOR CYCLE/SCOOTER-USED FOR HIRE | 2-Wheelers | 2W_Shared | 5.0 |
| 96842 | 2023.0 | dec | 12/1/2023 | Andaman & Nicobar Island | OMNI BUS | Bus | Bus | 0.0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 96843 | 2023.0 | dec | 12/1/2023 | Andaman & Nicobar Island | THREE WHEELER (GOODS) | 3-Wheelers | 3W_Goods | 0.0 |
| 96844 | 2023.0 | dec | 12/1/2023 | Andaman & Nicobar Island | THREE WHEELER (PASSENGER) | 3-Wheelers | 3W_Shared | 0.0 |

In [8]:

```
df.Year.value_counts() # so the data contains information 2014 to present.
```

Out[8]:

```
Year
2019.0    10315
2023.0    10279
2018.0    10225
2022.0    10021
2017.0     9799
2016.0     9348
2021.0     9249
2015.0     9052
```

```
2014.0     9022
2020.0     8675
2024.0      860
Name: count, dtype: int64
```

In [9]:

```
df.State.value_counts() # almost every state and UT are present in the data.
```

Out[9]:

```
State
Maharashtra                 4912
Karnataka                   4830
Uttar Pradesh               4557
Rajasthan                   4552
Gujarat                     4517
West Bengal                 4196
Tamil Nadu                  4063
Odisha                      4027
Haryana                     3842
Kerala                      3666
Chhattisgarh                3590
Madhya Pradesh              3587
Andhra Pradesh              3457
Assam                       3114
Uttarakhand                 3045
```

```
Himachal Pradesh            2980
Punjab                      2950
Jharkhand                   2773
Bihar                       2544
Jammu and Kashmir           2292
Arunachal Pradesh           2285
Goa                         2139
DNH and DD                  1927
Delhi                       1871
Meghalaya                   1867
Puducherry                  1832
Manipur                     1632
Nagaland                    1588
Tripura                     1564
Mizoram                     1557
Chandigarh                  1554
Sikkim                      1246
Andaman & Nicobar Island    1226
Ladakh                      1063
Name: count, dtype: int64
```

In [10]:

```
df.Vehicle_Class.value_counts() # below are the class of vehicles being sold in the Indian market.
```

Out[10]:

```
Vehicle_Class
MOTOR CAR                              4111
M-CYCLE/SCOOTER                        4101
GOODS CARRIER                          4096
MOTOR CAB                              3985
BUS                                    3813
                                       ...
SEMI-TRAILER (COMMERCIAL)                18
X-RAY VAN                                12
MOTOR CYCLE/SCOOTER-WITH TRAILER          9
MODULAR HYDRAULIC TRAILER                 3
MOTOR CARAVAN                             3
Name: count, Length: 73, dtype: int64
```

In [11]:

```
df.Vehicle_Category.value_counts() # Below are the category of vehicles being sold in Indian markets.
```

Out[11]:

```
Vehicle_Category
Others        54423
2-Wheelers    13121
3-Wheelers    11491
Bus            9119
4-Wheelers     8691
Name: count, dtype: int64
```

In [12]:

```
df.Vehicle_Type.value_counts() # Below are the types of vehicles being sold in Indian markets.
```

Out[12]:

```
Vehicle_Type
Others                 54423
2W_Personal            11700
Bus                     7026
4W_Shared               4580
4W_Personal             4111
3W_Shared               3786
3W_Goods                3208
Institution Bus         2093
3W_Shared_LowSpeed      1951
3W_Goods_LowSpeed       1517
2W_Shared               1421
3W_Personal             1029
Name: count, dtype: int64
```

In [13]:

```
df.drop(columns=['Year']).describe() # Basic statistics related to the EV sales in India Quantity wise.
```

Out[13]:

| | EV_Sales_ |
|---|---|

| | Quantity |
|---|---|
| count | 96845.000000 |
| mean | 37.108896 |
| std | 431.566675 |
| min | 0.000000 |
| 25% | 0.000000 |
| 50% | 0.000000 |
| 75% | 0.000000 |
| max | 20584.000000 |

Checking for Duplicates and Missing Values.

In [14]:

```
check_duplicates=df.duplicated().sum()
print(check_duplicates)
```

```
0
```

*No Duplicates present.*

In [15]:

```
check_missing_values=df.isnull().sum()
```

```
print(check_missing_values)
```

```
Year                0

Month_Name          0

Date                0

State               0

Vehicle_Class       0

Vehicle_Category    0

Vehicle_Type        0

EV_Sales_Quantity   0

dtype: int64
```

*No missing values present.*

Checking if the Datatypes are correct or not

In [16]:

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>

RangeIndex: 96845 entries, 0 to 96844

Data columns (total 8 columns):

 #   Column             Non-Null Count  Dtype

---  ------             --------------  -----

 0   Year               96845 non-null  float64

 1   Month_Name         96845 non-null  object

 2   Date               96845 non-null  object

 3   State              96845 non-null  object

 4   Vehicle_Class      96845 non-null  object

 5   Vehicle_Category   96845 non-null  object

 6   Vehicle_Type       96845 non-null  object

 7   EV_Sales_Quantity  96845 non-null  float64
```

```
dtypes: float64(2), object(6)

memory usage: 5.9+ MB
```

*The column Year is given as Float, but we should convert it to int.*

In [17]:

```
df['Year'] = df['Year'].astype(int)
```

*The column Date is given as Object, but it should be in Datetime format*

In [18]:

```
df['Date'] = pd.to_datetime(df['Date'], errors='coerce')
```

*Similarly converting other columns to their relevant datatypes.*

In [19]:

```
categorical_columns = ['Month_Name', 'State', 'Vehicle_Class',
'Vehicle_Category', 'Vehicle_Type']
df[categorical_columns] =
df[categorical_columns].astype('category')
```

Checking once again

In [20]:

```
df.info() # now everything is well organised.
```

```
<class 'pandas.core.frame.DataFrame'>
```

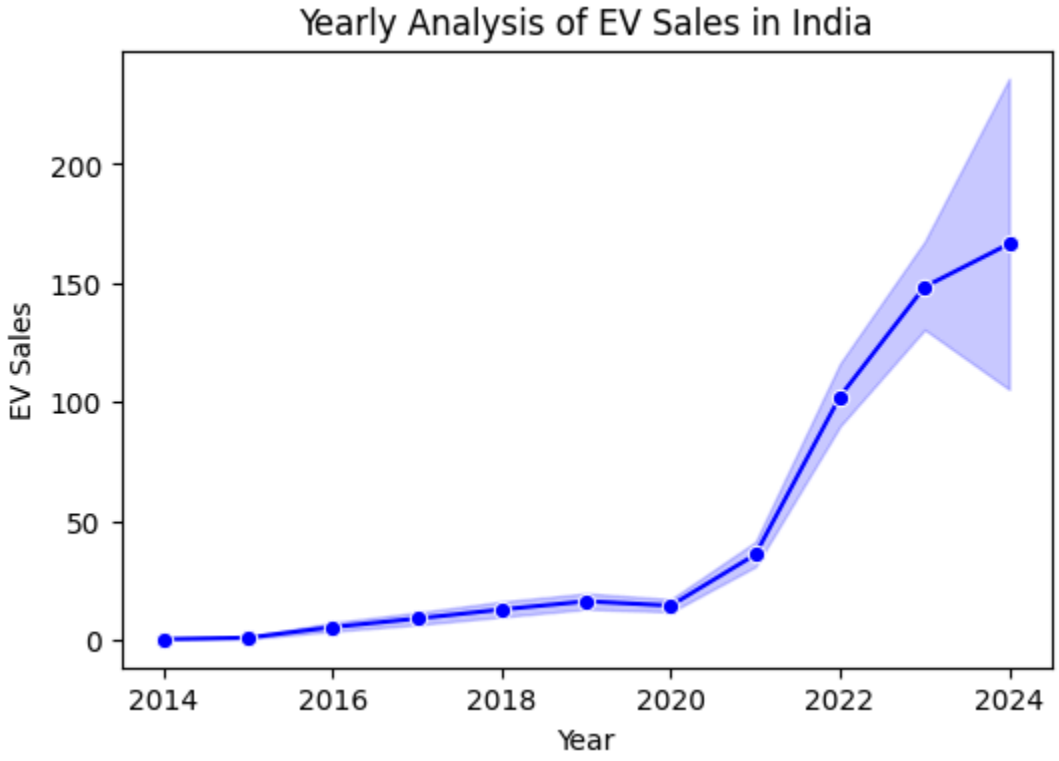
```
RangeIndex: 96845 entries, 0 to 96844

Data columns (total 8 columns):

 #   Column             Non-Null Count  Dtype

---  ------             --------------  -----

 0   Year               96845 non-null  int64

 1   Month_Name         96845 non-null  category

 2   Date               96845 non-null  datetime64[ns]

 3   State              96845 non-null  category

 4   Vehicle_Class      96845 non-null  category

 5   Vehicle_Category   96845 non-null  category

 6   Vehicle_Type       96845 non-null  category

 7   EV_Sales_Quantity  96845 non-null  float64

dtypes: category(5), datetime64[ns](1), float64(1), int64(1)
```

```
memory usage: 2.7 MB
```

Data Visualisation

In [21]:

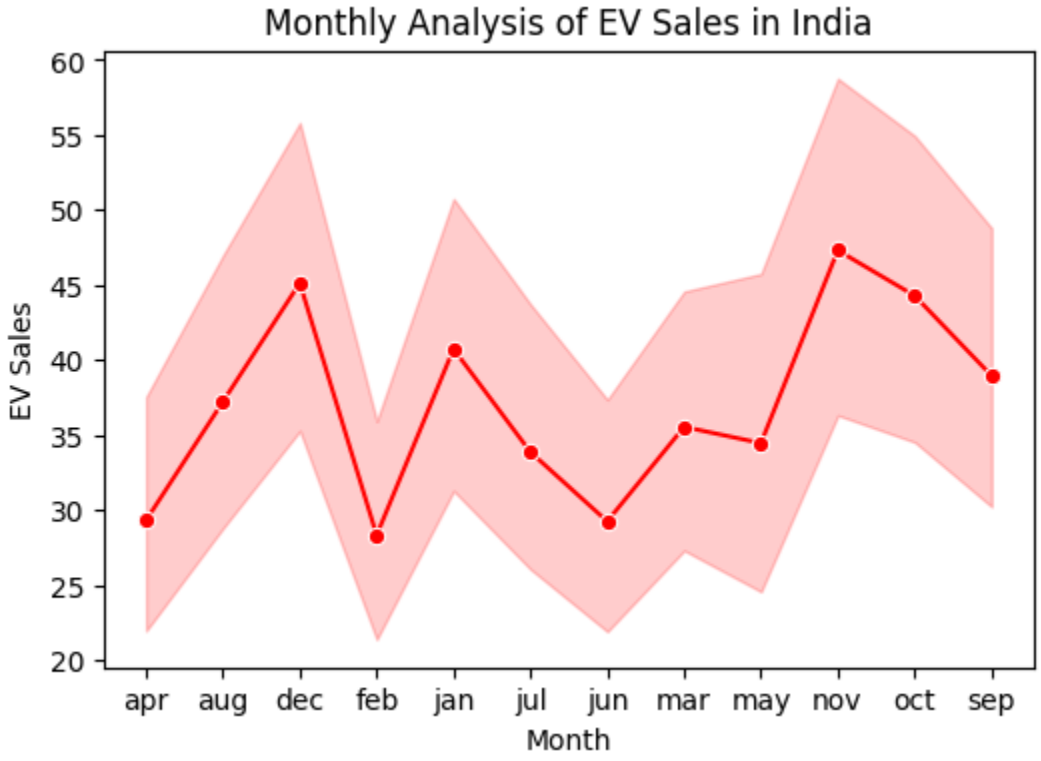
```
plt.figure(figsize=(6,4))
plt.title('Yearly Analysis of EV Sales in India')
sns.lineplot(x='Year', y='EV_Sales_Quantity', data=df,
marker='o', color='b')
plt.xlabel('Year')
plt.ylabel('EV Sales');
```




In [22]:

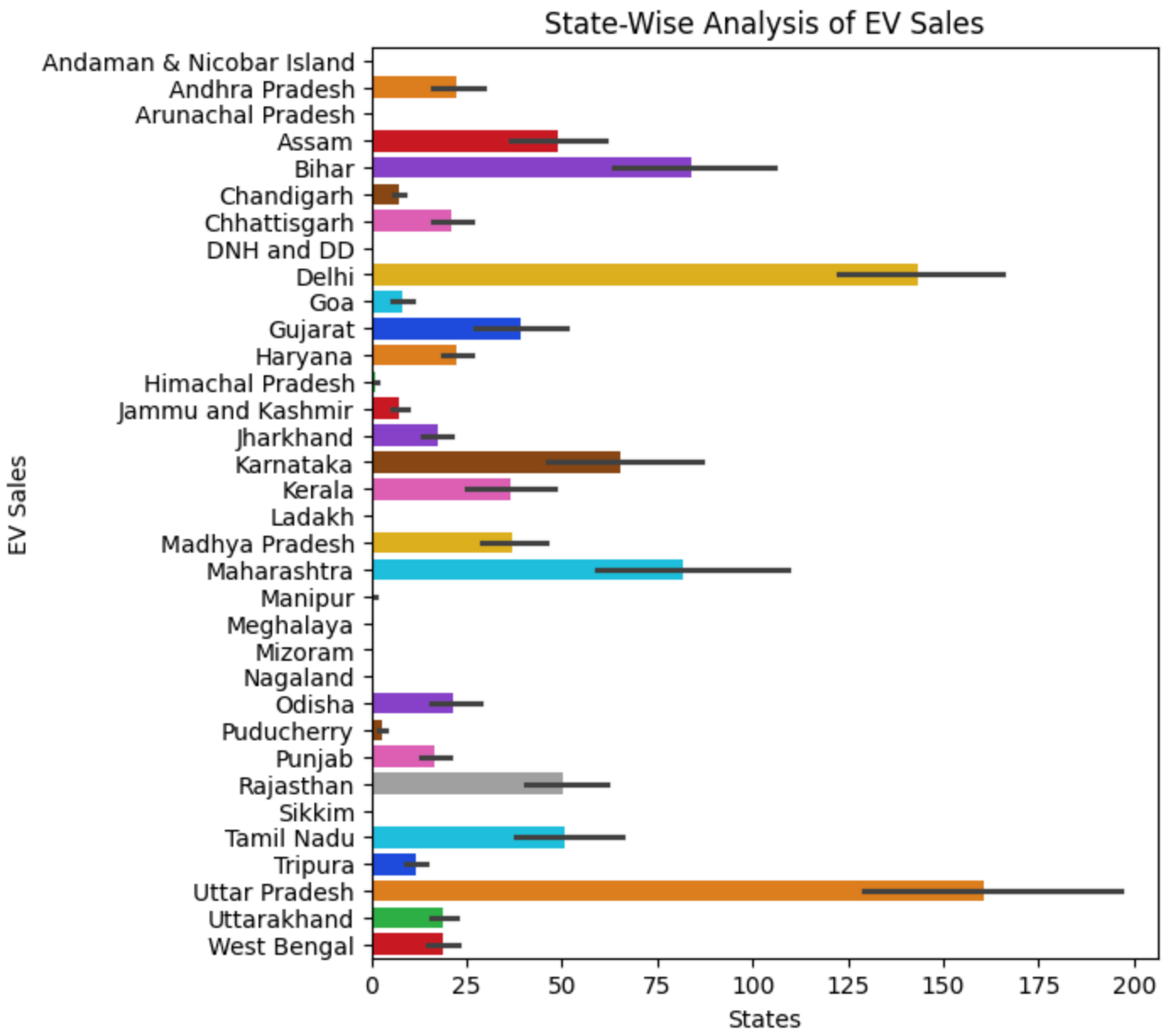
```
plt.figure(figsize=(6,4))
```

```
plt.title('Monthly Analysis of EV Sales in India')
sns.lineplot(x='Month_Name', y='EV_Sales_Quantity', data=df,
marker='o', color='r')
plt.xlabel('Month')
plt.ylabel('EV Sales');
```



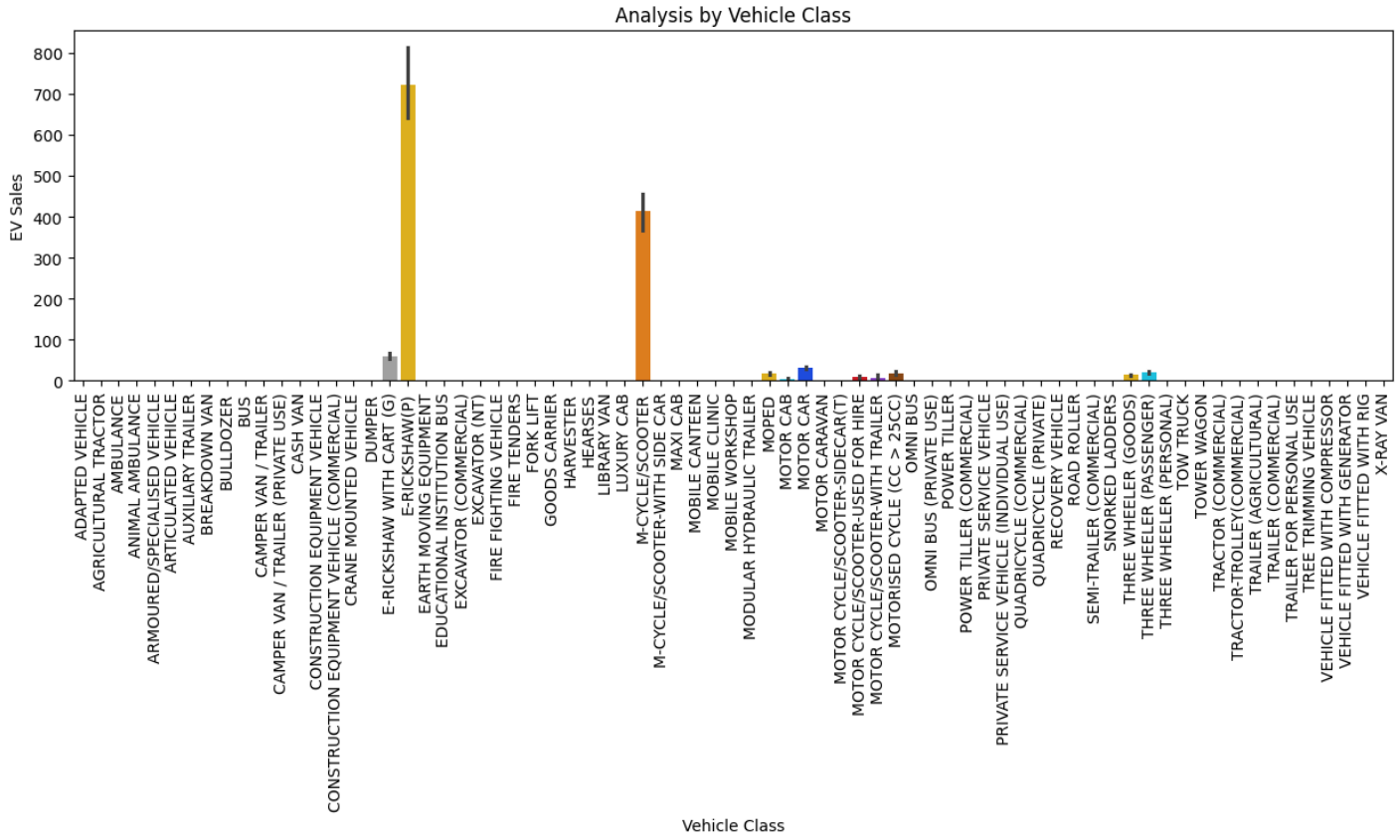

In [61]:

```
plt.figure(figsize=(6,7))
plt.title('State-Wise Analysis of EV Sales')
sns.barplot(y='State', x='EV_Sales_Quantity', data=df,
hue='State', palette='bright')
plt.xlabel('States')
plt.ylabel('EV Sales');
```



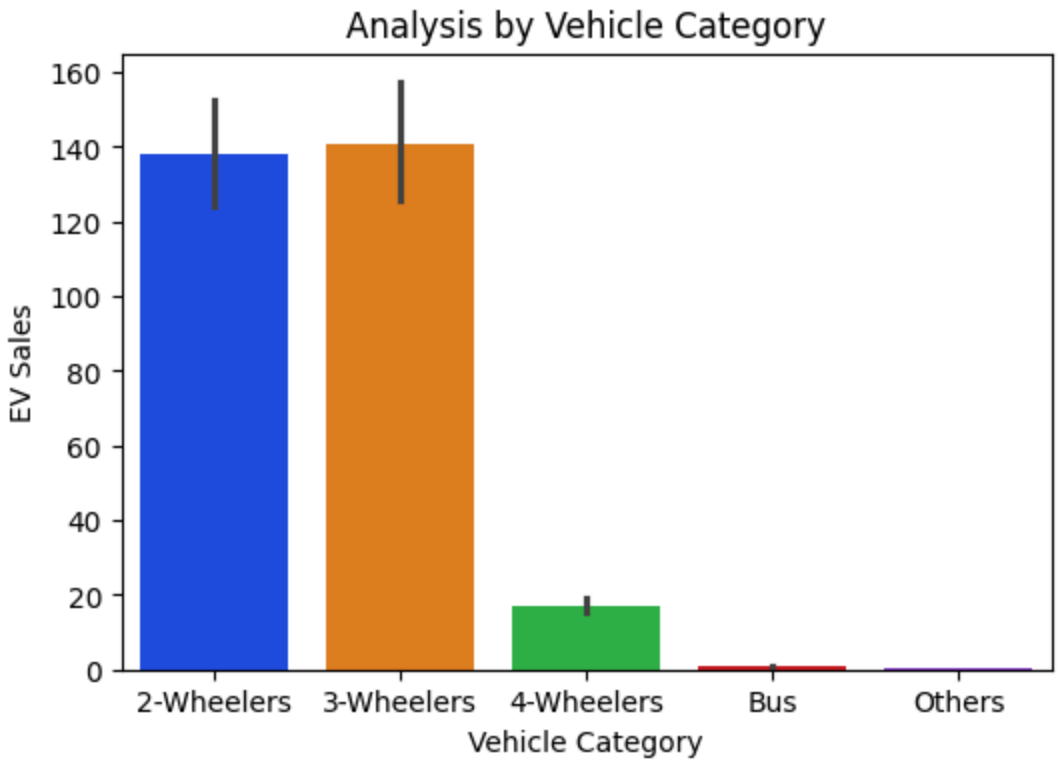

In [59]:

```
plt.figure(figsize=(15,4))
sns.barplot(x='Vehicle_Class', y='EV_Sales_Quantity',data=df,
hue='Vehicle_Class', palette='bright')
plt.title('Analysis by Vehicle Class')
plt.xlabel('Vehicle Class')
plt.ylabel('EV Sales')
plt.xticks(rotation=90);
```



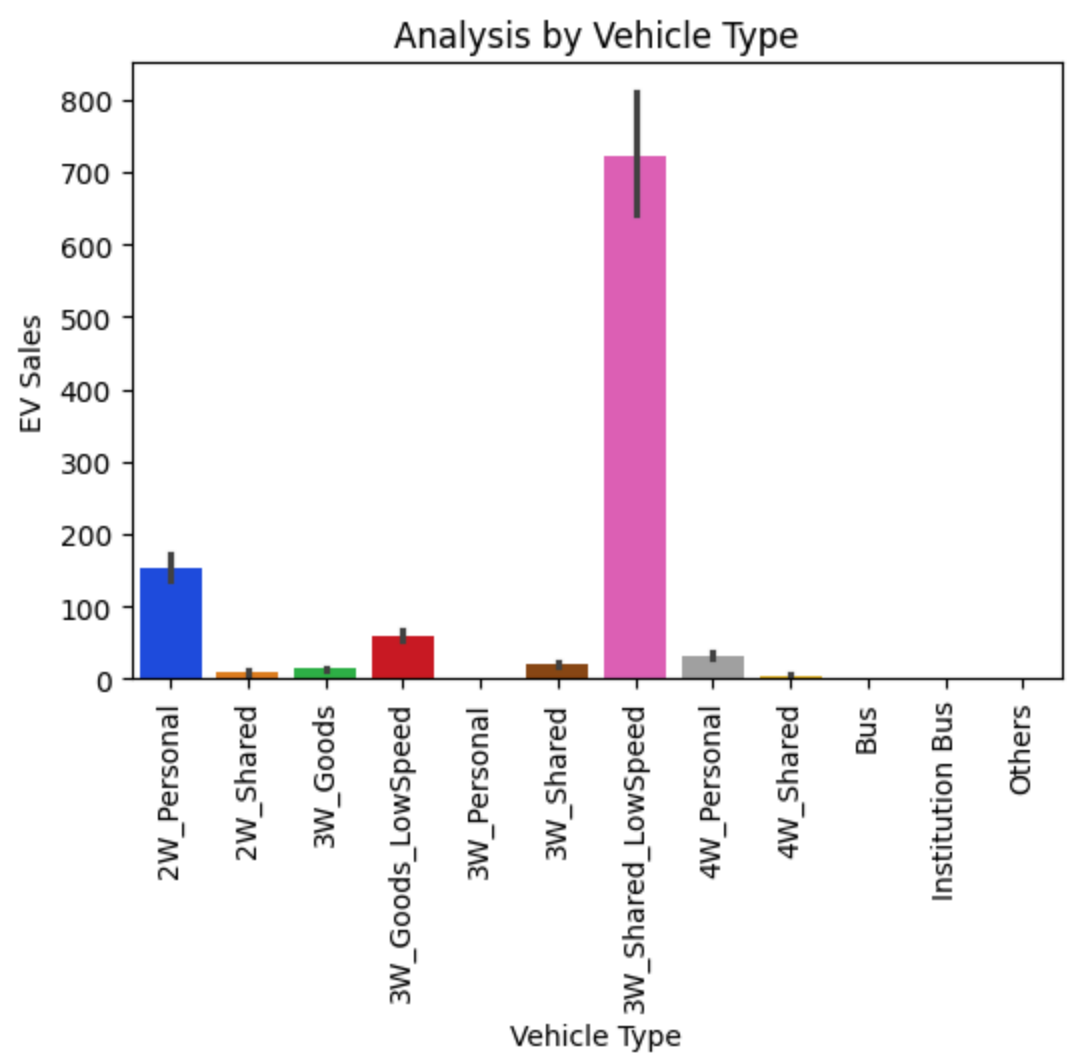

In [66]:

```
plt.figure(figsize=(6,4))
sns.barplot(x='Vehicle_Category',
y='EV_Sales_Quantity',data=df, hue='Vehicle_Category',
palette='bright')
plt.title('Analysis by Vehicle Category')
plt.xlabel('Vehicle Category')
plt.ylabel('EV Sales')
plt.xticks(rotation=0);
```




In [68]:

```
plt.figure(figsize=(6,4))
sns.barplot(x='Vehicle_Type', y='EV_Sales_Quantity',data=df,
hue='Vehicle_Type', palette='bright')
plt.title('Analysis by Vehicle Type')
plt.xlabel('Vehicle Type')
plt.ylabel('EV Sales')
plt.xticks(rotation=90);
```




[Reference link]