ELECTRIC VEHICLE MARKET SEGMENTATION ANALYSIS

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Github Link: https://github.com/Samplergithub769/Indian-EV-Market-from-2001---2024

Abstract

This project analyzes India's electric vehicle (EV) ecosystem, focusing on sales trends, market dynamics, and infrastructure development between 2015 and 2024. Using multiple datasets, the analysis covers key aspects such as EV sales by manufacturers, state-wise market presence, charging infrastructure, and vehicle categories. Key insights include year-over-year sales growth, overall market expansion, top-performing manufacturers, and market shares. The analysis highlights significant growth in EV adoption, with leading manufacturers like Ola Electric and TVS Motors dominating the market. Additionally, states such as Maharashtra emerge as leaders in EV manufacturing and public charging infrastructure. This comprehensive evaluation provides actionable insights into India's evolving EV landscape and its readiness to meet the increasing demand for sustainable transportation solutions.

1. Introduction

The global push for sustainable development and reduction in carbon emissions has driven the rapid adoption of electric vehicles (EVs) worldwide. India, as a key developing economy, has also seen a surge in EV adoption over the last decade. This study examines India's EV landscape by analyzing sales trends, leading manufacturers, and supporting infrastructure from 2015 to 2024. The objective is to evaluate the progress and challenges of transitioning to sustainable mobility in India.

2. Methodology

This analysis utilized multiple datasets containing information on EV sales, state-wise production data, market shares of manufacturers, and availability of public charging stations in India. The steps involved include:

- **Data Collection**

  The dataset used for the analysis was obtained from Kaggle, a trusted platform for open-source datasets.

About Dataset

This dataset provides a detailed overview of the electric vehicle (EV) market in India from 2001 to 2024. It includes monthly sales data, sales data categorized by manufacturer, and vehicle class-wise sales data for different manufacturers. This dataset is ideal for market analysis, trend forecasting, and research on the adoption and growth of electric vehicles in India.

1. **EV Maker by Place**
    - List of popular EV Makers and their location of Manufacturing Plant.
2. **Operational PC**
    - Total Operational Public Charging Station for EV available in each state
3. **Vehicle Class**
    - Total vehicles (includes electric and all other fuels) registered (manufactured) by category from 2001 - Aug 2024
4. **v_cat_01-24**
    - Total electric vehicles manufactured from 2001 - Aug 2024 and vehicle category
5. **ev_sales_by_makers_and_cat_15-24**
    - Total electric vehicles manufactured by makers from 2015 - Aug 2024 with the vehicle class

- **Data Preprocessing**
    1. **Import Necessary Libraries**
        - **pandas:** For data manipulation and analysis.
        - **numpy:** For numerical operations and handling arrays.
        - **matplotlib.pyplot and seaborn:** For data visualization
    2. **Load the Dataset**

        The dataset is read from a CSV file using the pandas function read_csv().
    3. **Inspect the data**
        - **evsales.info():** to check the data types and identify missing values.
        - **evsales.isnull().sum():** command is used to detect the missing (null) values in the DataFrame evsales.

- **Exploratory Data Analysis (EDA)**

  Visualizing key trends in sales growth, manufacturer performance, and state-wise adoption.

  1. **Total Sales by Year**

     We calculated the total sales across all categories for each year from 2015 to 2024.

Total Sales by Year

```
[37]: year_total = evsales.iloc[:,2:].sum()
      year_total
```

t[37]:

	0
2015	7752
2016	49249
2017	87019
2018	129763
2019	165786
2020	123770
2021	328854
2022	1020533
2023	1529234
2024	978943

  2. **Year Over Year Growth**

     This calculates the Year Over Year (YoY) growth rate. The results show fluctuating growth rates, with some years experiencing a decline (e.g., 2020), while others show rapid growth (e.g., 2021-2022).

```
#calculate year over year growth
yoy_growth = year_total.pct_change()*100
yoy_growth
```

	0
2015	NaN
2016	535.307018
2017	76.691913
2018	49.120307
2019	27.760610
2020	-25.343515
2021	165.697665
2022	210.330116
2023	49.846600
2024	-35.984748

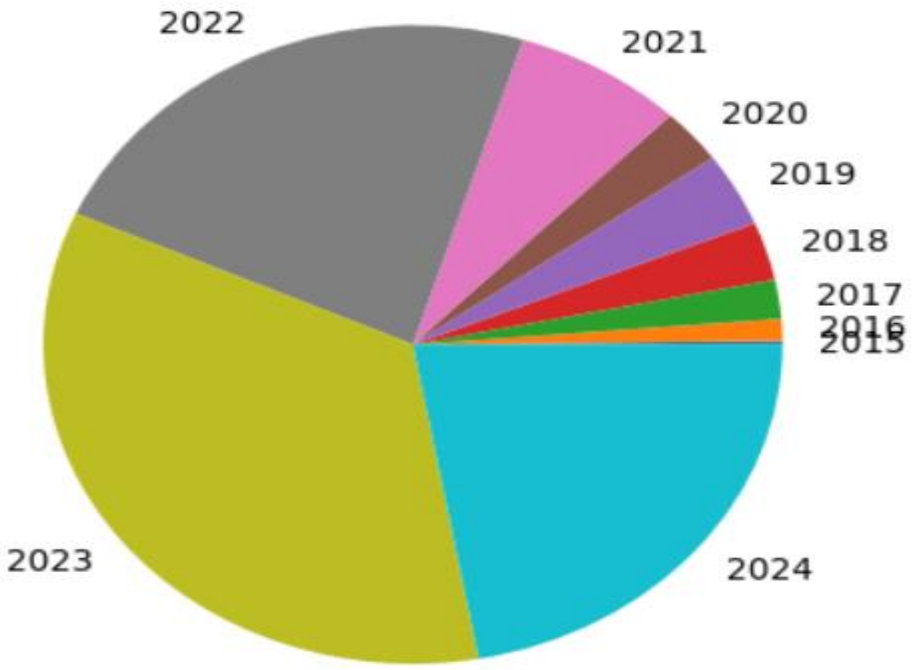
dtype: float64

3. **Plot Yearly Sales**

Plot Yearly Sales

```
year_total.plot(kind = 'pie')
```

```
<Axes: >
```



4. **Overall Growth from 2015 to 2024**

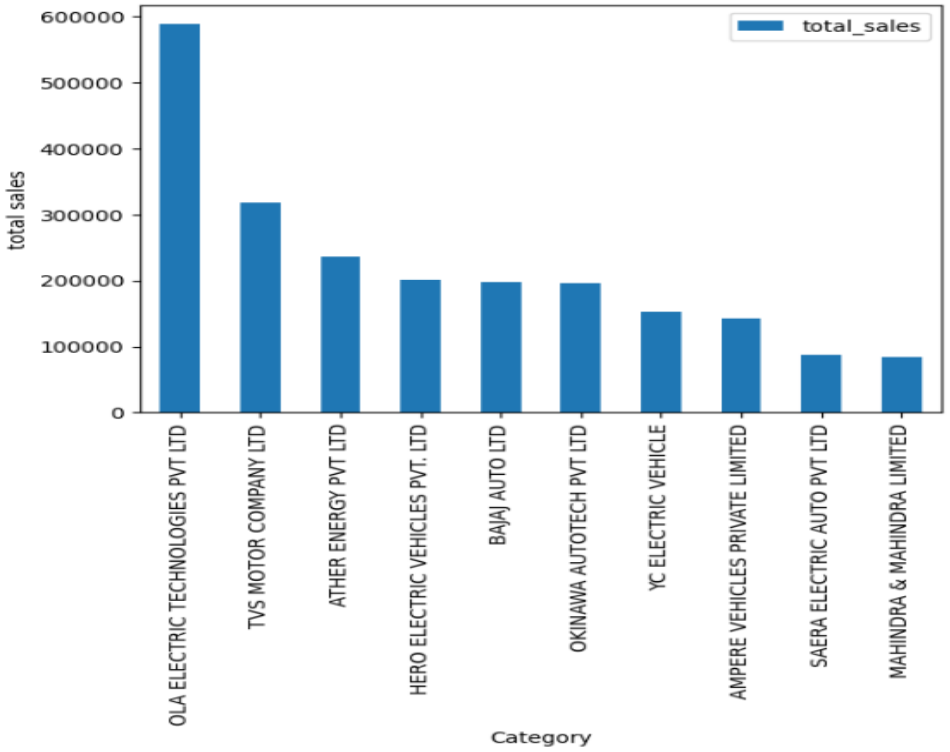
   The overall growth between 2015 and 2024 is an impressive **12,628%**.

5. **Manufacturer Performance: Total Sales per Manufacturer**
   - A new column total_sales is created by summing up the sales for each manufacturer over the years.
   - We group the data by manufacturer (Maker) and calculate their total sales.
6. **Top 10 Manufacturers**

Top 10 Manufacturers

```
#bar representation for top ten companies
df = Manufacturers_sales.iloc[:10,:]
df.plot(kind='bar', x='Maker', y='total_sales')
plt.xlabel('Category')
plt.ylabel('total sales')
```

```
Text(0, 0.5, 'total sales')
```



7. Market Share Calculation

The market share for each manufacturer is calculated by dividing their total sales by the total market sales.

```
Manufacturers_sales['market share(%)'] = (Manufacturers_sales['total_sales'] /total_market_sales)*100
```

```
Manufacturers_sales
```

	Maker	total_sales	market share(%)
738	OLA ELECTRIC TECHNOLOGIES PVT LTD	588266	13.306467
1056	TVS MOTOR COMPANY LTD	318445	7.203166
100	ATHER ENERGY PVT LTD	236387	5.347030
411	HERO ELECTRIC VEHICLES PVT. LTD	201785	4.564339
126	BAJAJ AUTO LTD	198498	4.489988
...	...	...	...
886	SAN MOTORS LIMITED	1	0.000023
443	IDEAL JAWA INDIA PVT LTD	1	0.000023
46	AKSMD RECHARGEABLE VEHICLES PVT LTD	1	0.000023
881	SAKTHI VIJAY INDUSTRIES	1	0.000023
944	SHRI RAM INDUSTRIES	1	0.000023

196 rows × 3 columns

8. Geographical Data Analysis

Count the number of EV makers operating in each state.

```
#count number of ev manufacturing by state
absev_market_by_state =ev_market_place.groupby('State')['EV Maker'].count().reset_index()
absev_market_by_state
```

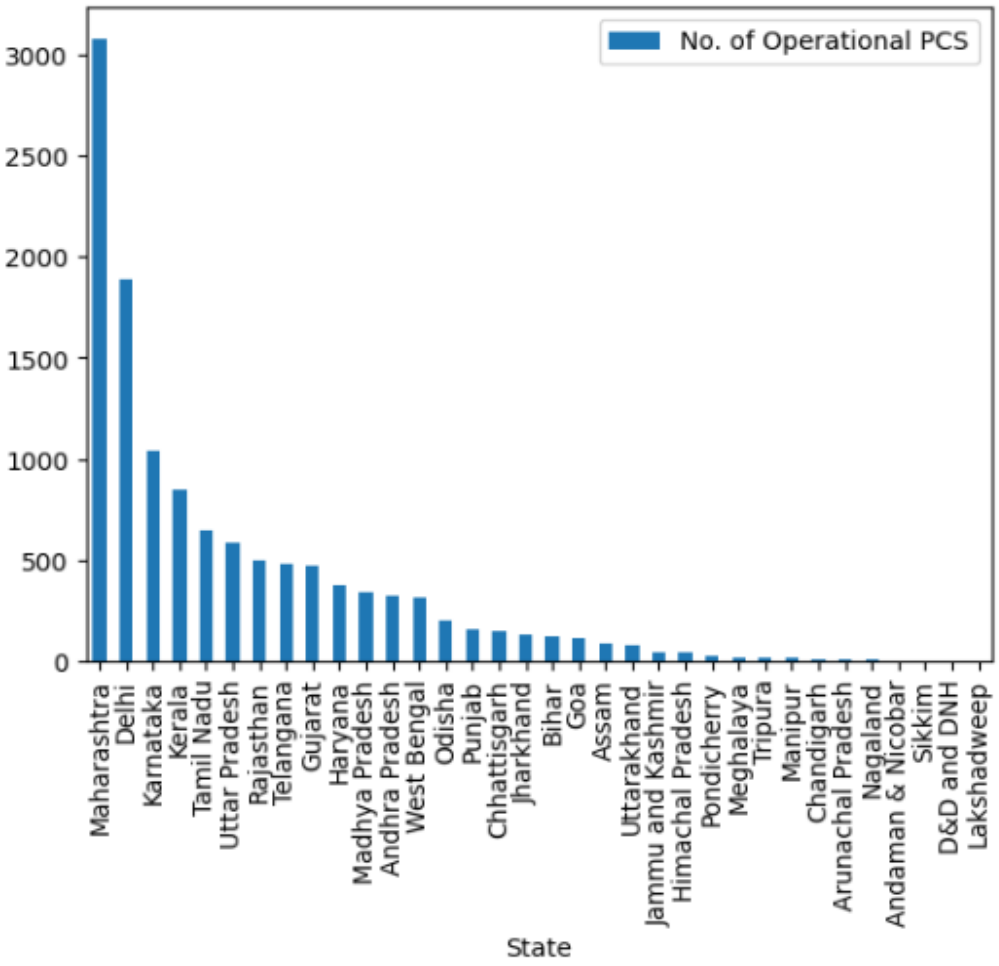
	State	EV Maker
0	Andhra Pradesh	1
1	Delhi	4
2	Gujarat	5
3	Haryana	6
4	Karnataka	6
5	Madhya Pradesh	1
6	Maharashtra	15
7	Punjab	1
8	Rajasthan	4
9	Tamil Nadu	11
10	Telangana	3
11	Uttarakhand	2
12	West Bengal	3

9. EV Charging Stations by State

The number of EV charging stations by state is visualized using a bar chart.

```
evcharging_station.plot(kind = 'bar' ,x ='State' ,y ='No. of Operational PCS' )
```

```
<Axes: xlabel='State'>
```



10. Segmentation Based on EV Sales

Manufacturers are categorized into **high**, **medium**, and **low** sales segments based on their total sales.

This categorizes manufacturers into high, medium, and low sales segments.

```
]: high_sales = Manufacturers_sales[Manufacturers_sales['total_sales'] > 100000]
medium_sales = Manufacturers_sales[(Manufacturers_sales['total_sales'] <= 100000) & (Manufacturers_sales['total_sales'] > 5
low_sales = Manufacturers_sales[Manufacturers_sales['total_sales'] <= 50000]

print(f"High Sales Manufacturers:\n{high_sales}")
print(f"Medium Sales Manufacturers:\n{medium_sales}")
print(f"Low Sales Manufacturers:\n{low_sales}")
```

```
High Sales Manufacturers:
                                Maker  total_sales  market share(%)
738   OLA ELECTRIC TECHNOLOGIES PVT LTD       588266        13.306467
1056              TVS MOTOR COMPANY LTD       318445         7.203166
100                ATHER ENERGY PVT LTD       236387         5.347030
411     HERO ELECTRIC VEHICLES PVT. LTD       201785         4.564339
126                      BAJAJ AUTO LTD       198498         4.489988
737            OKINAWA AUTOTECH PVT LTD       196182         4.437600
1170                YC ELECTRIC VEHICLE       152951         3.459723
63      AMPERE VEHICLES PRIVATE LIMITED       141805         3.207603
Medium Sales Manufacturers:
                                  Maker  total_sales  market share(%)
869             SAERA ELECTRIC AUTO PVT LTD        87481         1.978804
640             MAHINDRA & MAHINDRA LIMITED        84794         1.918024
1033  TATA PASSENGER ELECTRIC MOBILITY LTD         74410         1.683140
231             DILLI ELECTRIC AUTO PVT LTD        69966         1.582618
751                               OTHERS           68108         1.540590
176                    CHAMPION POLY PLAST         53493         1.210002
1032    TATA MOTORS PASSENGER VEHICLES LTD         52520         1.187993
Low Sales Manufacturers:
                                  Maker  total_sales  market share(%)
645       MAHINDRA LAST MILE MOBILITY LTD        46534         1.052590
677                   MINI METRO EV L.L.P        44250         1.000927
769              PIAGGIO VEHICLES PVT LTD        43783         0.990363
368     GREAVES ELECTRIC MOBILITY PVT LTD        42879         0.969915
1072                 UNIQUE INTERNATIONAL        41615         0.941324
...                                   ...          ...              ...
886                    SAN MOTORS LIMITED            1         0.000023
443              IDEAL JAWA INDIA PVT LTD            1         0.000023
46    AKSMD RECHARGEABLE VEHICLES PVT LTD            1         0.000023
881                SAKTHI VIJAY INDUSTRIES            1         0.000023
944                    SHRI RAM INDUSTRIES            1         0.000023

[1181 rows x 3 columns]
```

3. Result

1. **Sales Growth:** EV sales grew dramatically (12,628%) from 2015 to 2024. However, the YoY growth fluctuated, with significant drops in 2020 and 2024.
2. **Top Manufacturers:**
    - Ola Electric leads the market with ~13.3% share.
    - TVS Motor Company and Ather Energy are the next top contributors.
3. **Geographical Concentration:**
    - Manufacturing Hubs: Maharashtra (15 EV makers), Tamil Nadu (11 EV makers).
    - Top Charging Infrastructure: Maharashtra, Delhi, and Karnataka have the highest number of public charging stations.

4. Conclusion

Overall, the EV industry in India is on an upward trajectory, with rapid growth in both sales and infrastructure. The government's continued support, along with the efforts of manufacturers and service providers, will be crucial in shaping the future of this sector. Continued innovation, along with a robust charging network, will be essential in ensuring the widespread adoption of electric vehicles across the country.

5. Reference

1. **https://www.kaggle.com/datasets/srinrealyf/india-ev-market-data/data**
2. **https://www.kaggle.com/code/fireeagle123/indian-ev-data-analusise**
3. **https://www.kaggle.com/code/kavyachippada/mini-hackathon2-0**