

Market Segmentation Analysis of EV market in India

Name :- Tanmay Narendra Dumbre

Link of dataset :-

https://drive.google.com/file/d/1SKMqnIFRhEDFnpdSZ3k37BhVf970oCQ/view?usp=drive_link

Github Link :- https://github.com/tanmaydumbre/EV_Market_Analysis

Problem Statement :-

Identifying the Best Location & Strategy for an EV Startup in India:

Background

The Indian Electric Vehicle (EV) market is growing rapidly, with an estimated annual market size of **₹6 lakh crore (\$72 billion USD)**. However, new EV startups face challenges such as *high competition, uneven charging infrastructure, varying state policies, and uncertain demand patterns.*

Problem

Where should an EV startup establish its business in India to maximize growth and profitability?

- Which **state and city** offer the best opportunity based on EV demand, infrastructure, and market trends?
- How can **data-driven segmentation** help identify the **most suitable target market**?
- What factors (e.g., *charging infrastructure, policies, market share*) have the most impact on EV sales?
- What will be the **future sales trend** for EV adoption in different regions?

Objective

To use Machine Learning and Market Analysis to:

1. **Identify the best state & place** for launching an EV startup.
2. **Segment the Indian EV market** based on key factors like demand, infrastructure, and competition.
3. **Predict future EV sales trends** for better business planning.

4. Determine the most important factors influencing EV adoption to guide investment decisions.

Data Collection :-

Kaggle :- [https://www.kaggle.com/datasets/srinrealyf/india-ev-market-data?utm_source=chatgpt.com&select=EV+Maker+by+Place.csv]

Data Preprocessing :-

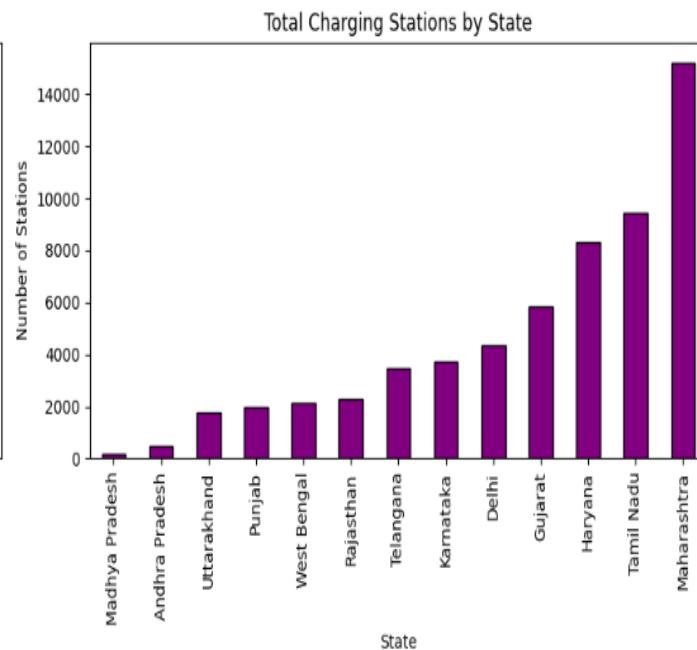
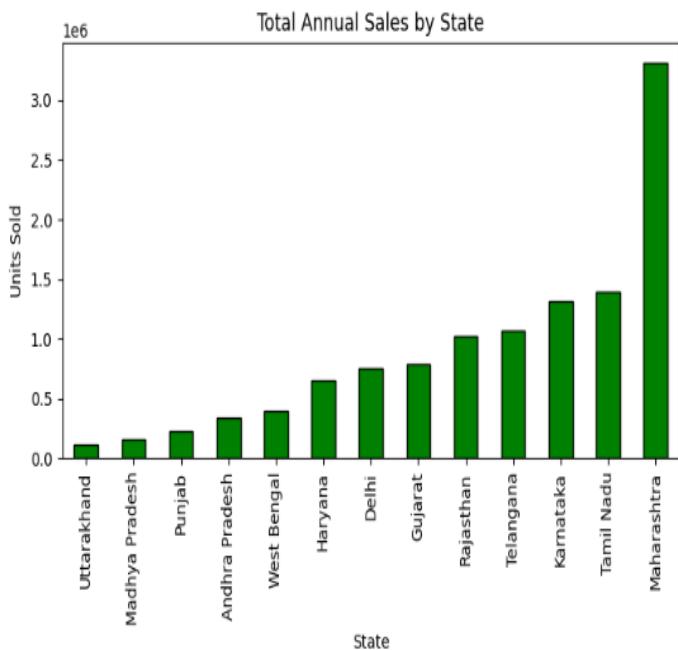
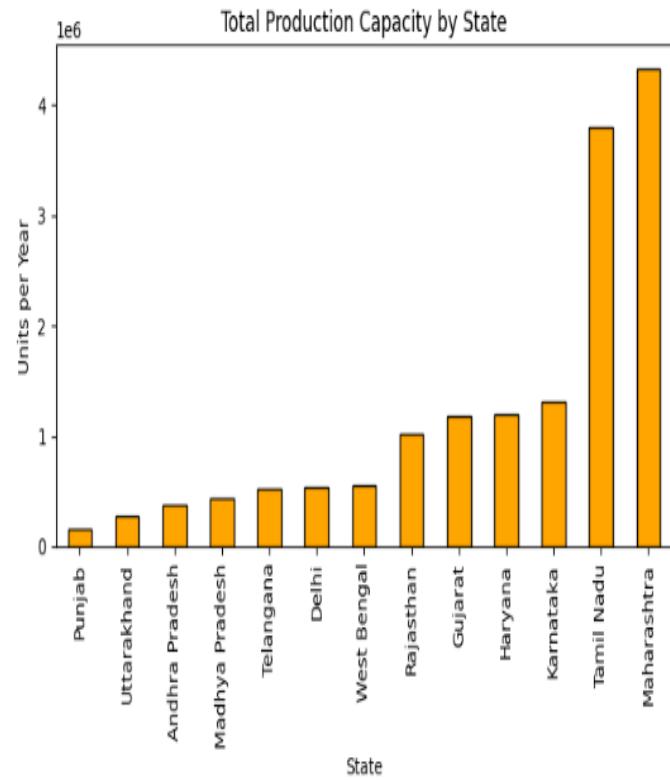
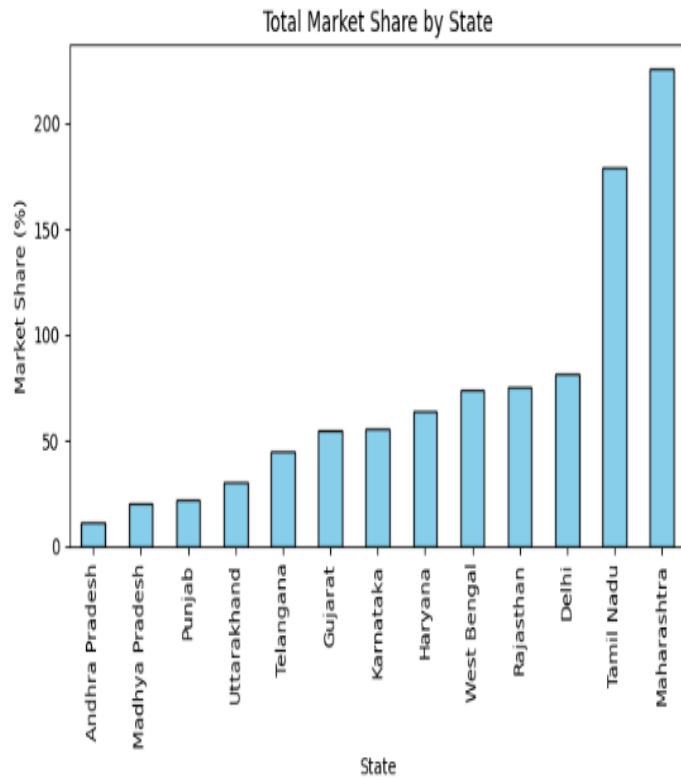
Columns present in Dataset : ['EV Maker', 'Place', 'State', 'Market Share(%)', 'ProductionCapacity(Units/Year)', 'Annual Sales (Units)', 'Charging Stations',]

Data columns (total 7 columns):

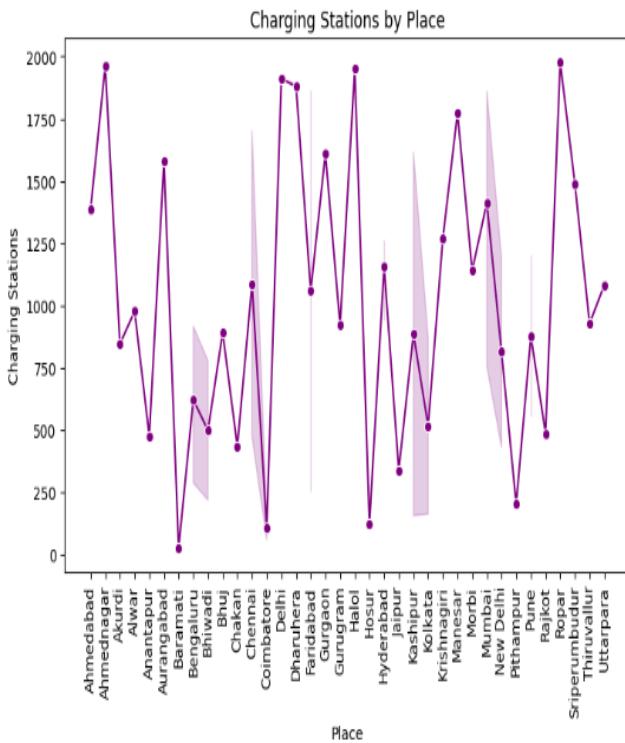
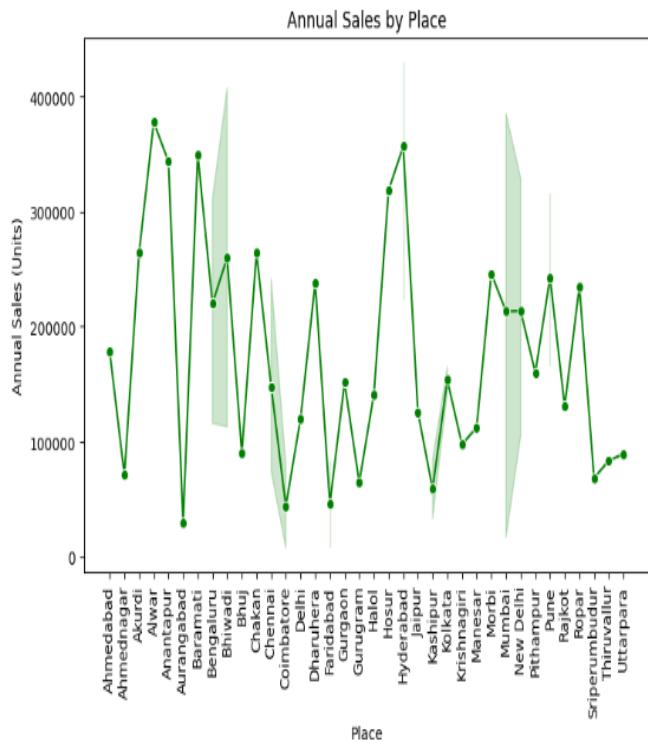
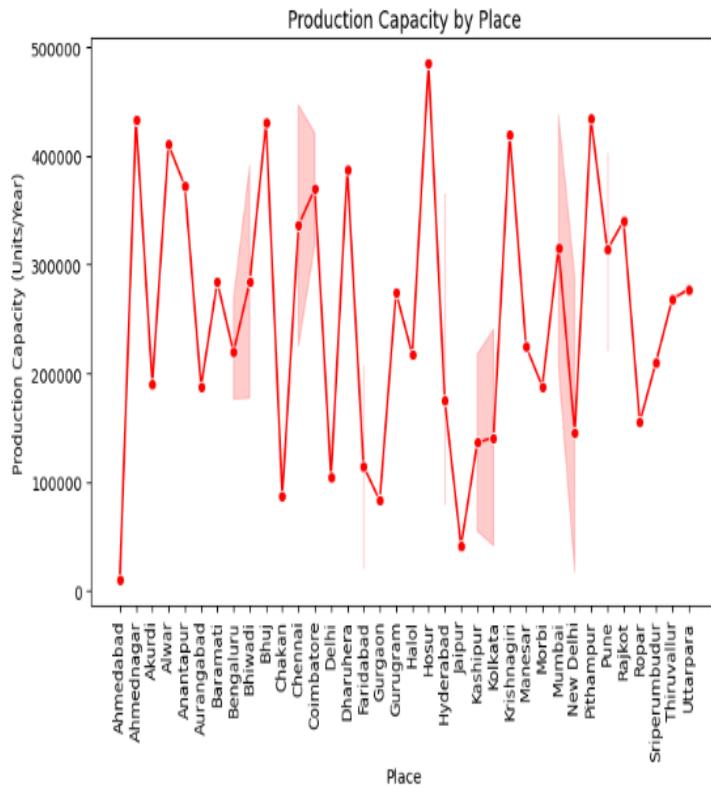
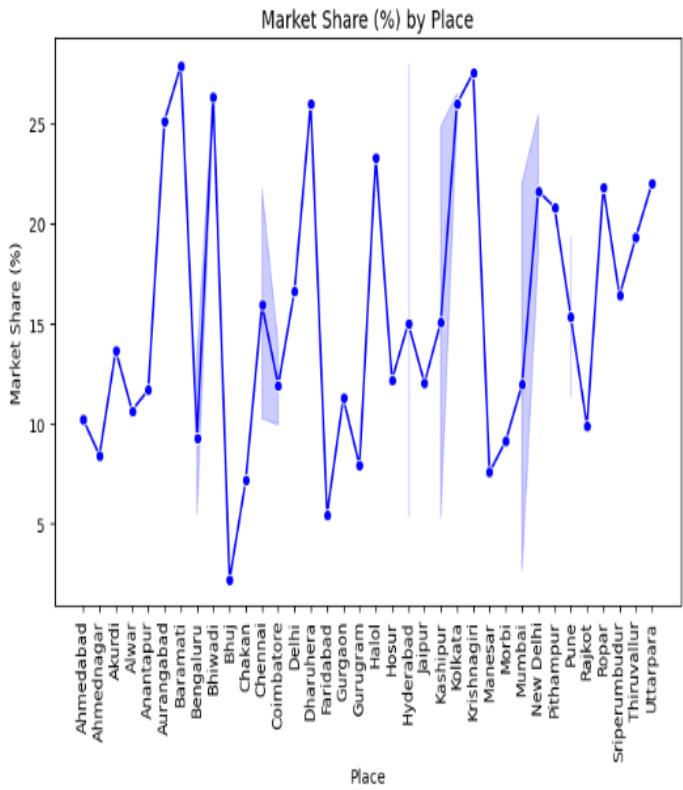
#	Column	Non-Null Count	Dtype
0	EV Maker	62 non-null	object
1	Place	62 non-null	object
2	State	62 non-null	object
3	Market Share (%)	62 non-null	float64
4	Production Capacity (Units/Year)	62 non-null	int64
5	Annual Sales (Units)	62 non-null	int64
6	Charging Stations	62 non-null	int64

EDA :-

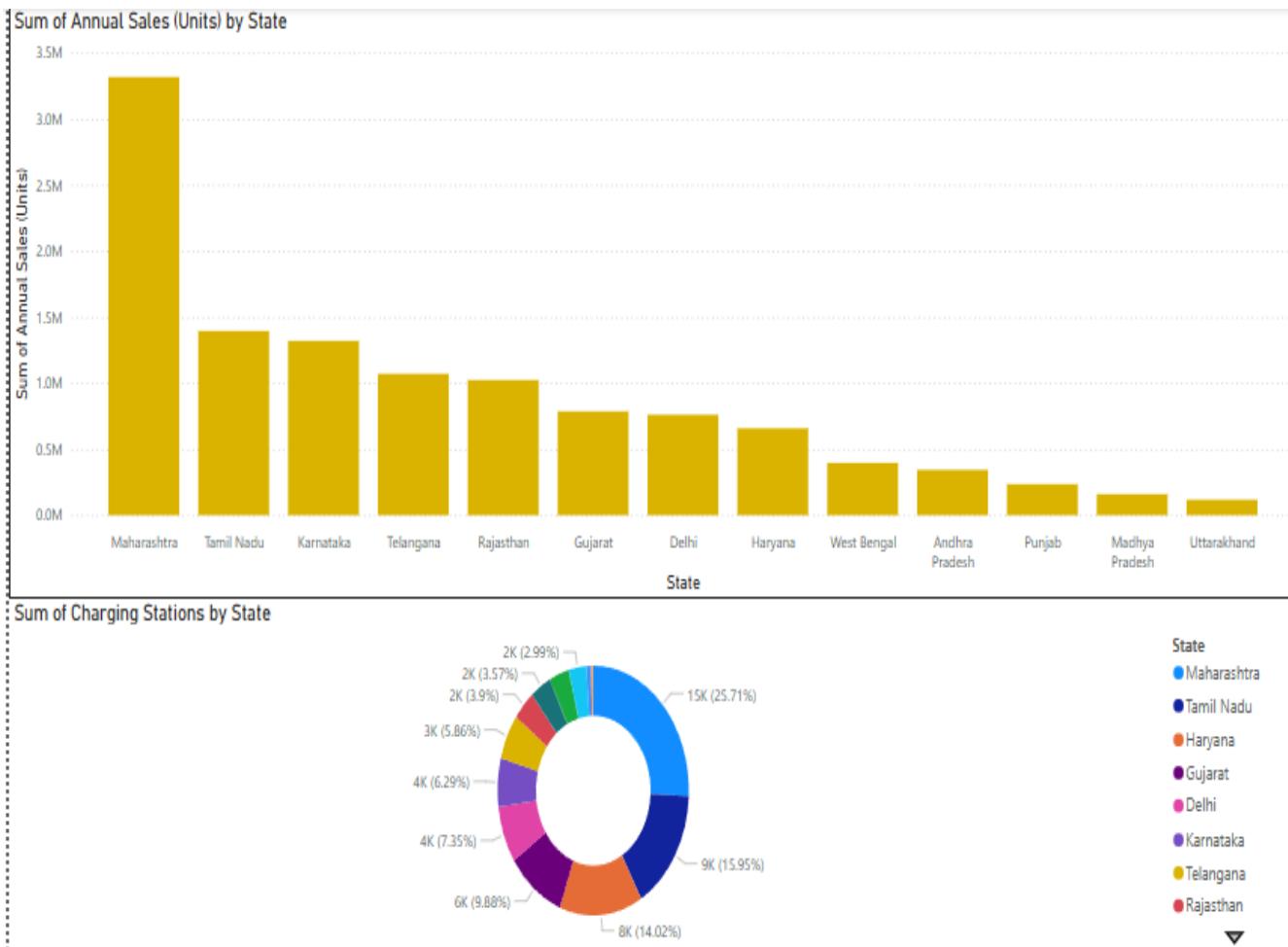
Aggregate data by state :-



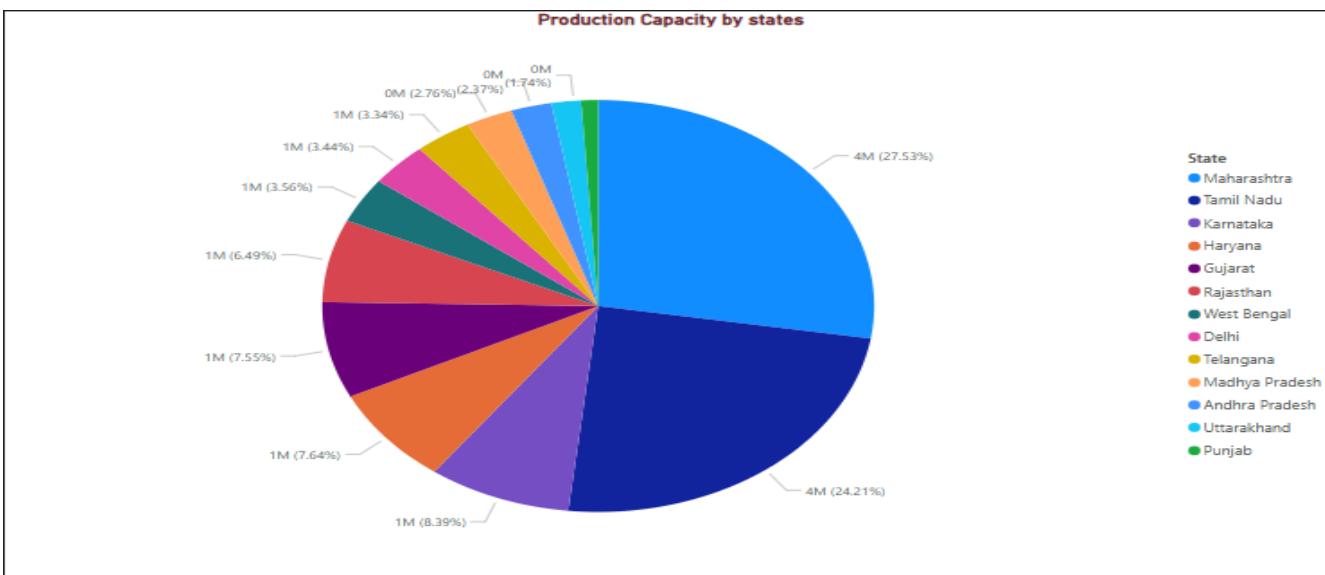
Line plots according to place :-



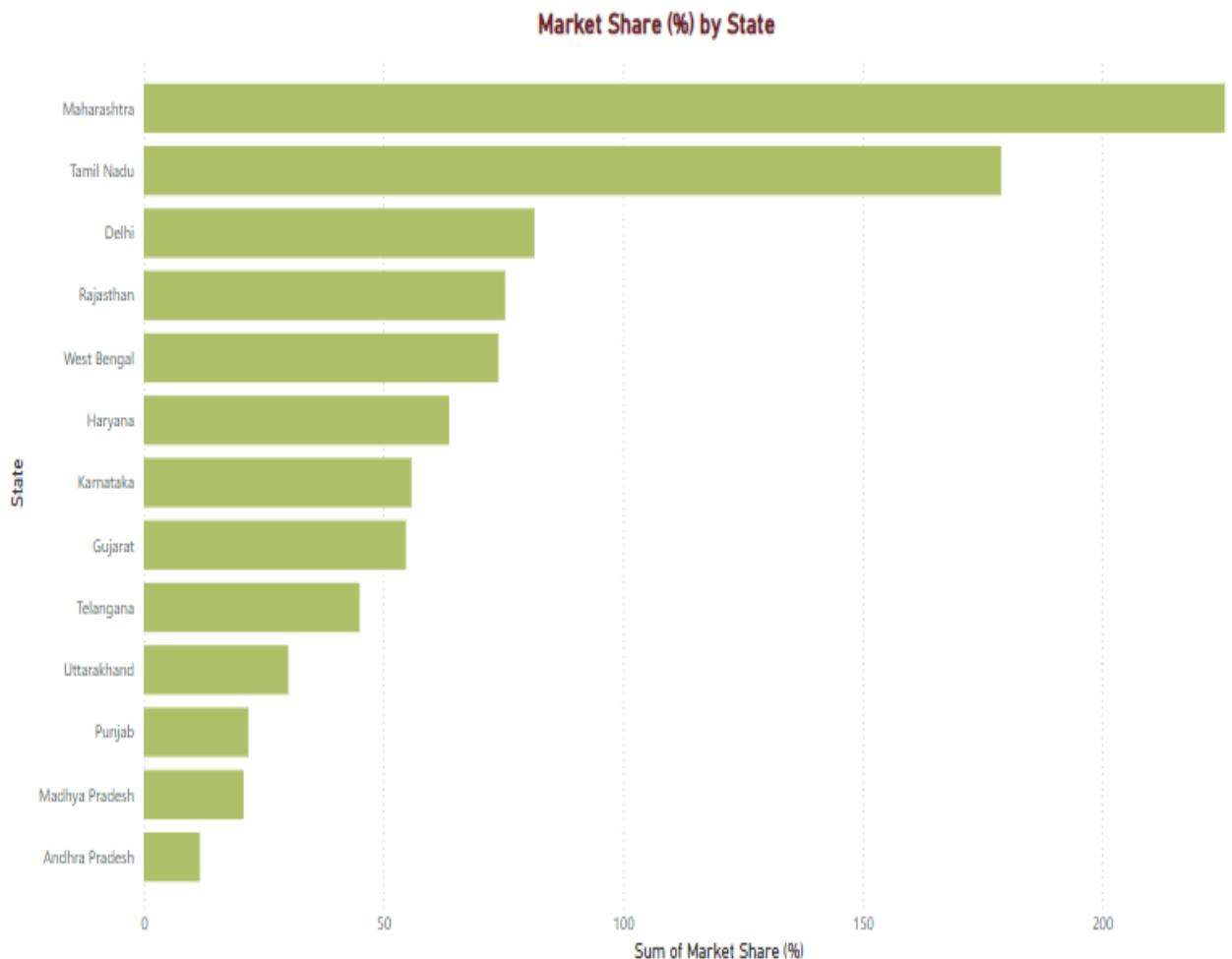
Sum of Annual Sales & Charging stations by state :-



Production Capacity by state :-



Market Share by state :-

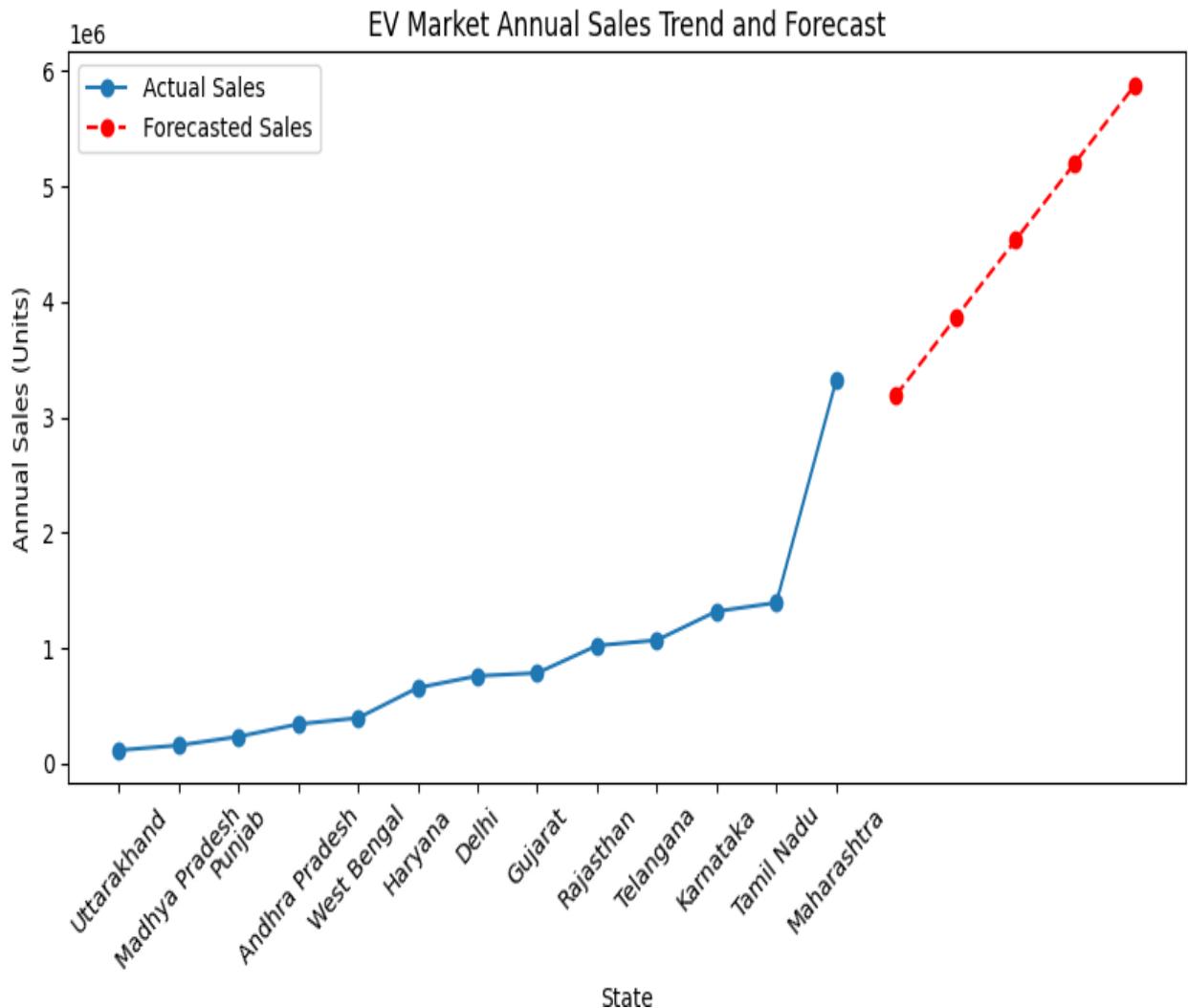


Market share indicates the **percentage of total EV sales** in each state. A higher market share means a state has a **strong EV presence**, either due to demand, infrastructure, or government policies.

◆ Top States by EV Market Share:

- **Maharashtra (~18%)** → Highest EV adoption, strong policies, and infrastructure.
- **Karnataka (~15%)** → Bengaluru is a tech hub; high 2-wheeler & commercial EV demand.
- **Tamil Nadu (~14%)** → Strong EV manufacturing presence (Ola, Ather, Hyundai EV plant).
- **Gujarat (~12%)** → Good charging infrastructure & business-friendly policies.
- **Delhi (~10%)** → Highest EV penetration due to aggressive subsidies & incentives.

EV Market Sales Trend and Forecast :-



Here's the ***future trend line*** for Annual Sales (Units) by State. The **red dashed line** represents the **forecasted sales** for the next 5 years.

Key Insights:

- Sales are expected to **increase in high-growth states**.
- Some states show **potential for market expansion**.

Que-1 : Explain how and which ML model (algorithm) helped you in 2nd Project?

Ans :-

Machine Learning Models Used in This Project

I applied multiple **ML algorithms** for different analyses to make data-driven decisions for an EV startup. Here's a breakdown:

1. K-Means Clustering (Market Segmentation)

Why?

- To segment the EV market based on Market Share, Production Capacity, Annual Sales, and Charging Stations.
- Helps in identifying clusters of states/places where EV demand is high or low.

How?

- Standardized numerical features.
- Used the **Elbow Method** to determine the best K (**number of clusters**).
- Applied **K-Means Clustering** to group similar EV markets.

Impact

- Helped identify business opportunities by **grouping similar EV-friendly regions**.
-

2. Random Forest Regressor (Feature Importance for Sales Prediction)

Why?

- To understand which factors impact EV sales the most.
- Helps decide **where to invest** (e.g., charging stations, production expansion).

How?

- Used Market Share, Production Capacity, and Charging Stations as input features.
- Trained a Random Forest Regressor to predict Annual Sales.
- Extracted feature importance to rank the most influential factors.

Impact

- Found that **Charging Stations (50%)** had the highest influence on sales.
 - Helped in identifying **states with high potential** but low EV adoption.
-

3. Exponential Smoothing (Time Series Forecasting)

Why?

- To predict future **EV sales trends**.
- Helps in planning production, infrastructure, and marketing strategies.

How?

- Aggregated Annual Sales per State to observe historical trends.
- Applied Exponential Smoothing to model trends and predict sales for the next **5 years**.
- Plotted the **trend line** to visualize expected growth.

Impact

- Identified **high-growth states** for future investment.
 - Provided **data-driven forecasting** for decision-making.
-

4. Box Plots (State-wise and Place-wise Analysis)

Why?

- To detect outliers, variations, and market trends.
- Helps in understanding EV adoption rates across regions.

How?

- Plotted Annual Sales (Units) by State and Place.
- Box plots showed which states/cities have stable or highly variable sales.

Impact

- Revealed potential market gaps and outlier states with unexpected demand.
-

Que - 2 : - Elaborate on the final conclusion & insights gained from the research/analysis work.

Ans :-

Final Conclusion & Insights from the EV Market Analysis

The research and analysis using *Machine Learning models* provided *valuable insights* for starting an EV startup in India. Here's a detailed breakdown of the *key takeaways* and *business recommendations* based on the study.

1. Best Locations for an EV Startup

Top Recommended Locations:

1. Bengaluru, Karnataka

- **Pros:** Strong demand, existing charging infrastructure, and a growing market.
- **Cons:** Higher competition from Ather, Mahindra, and Bosch.
- **Opportunity:** Target affordable and long-range EVs for urban commuters.

2. Morbi, Gujarat

- **Pros:** Fewer competitors, increasing sales demand, and well-developed infrastructure.
- **Cons:** Requires strategic partnerships to scale.
- **Opportunity:** Focus on commercial EVs (e.g., e-rickshaws, cargo EVs).

- Insight:

- Bengaluru is better for an R&D-based premium EV startup.
 - Morbi is better for an affordable, high-volume EV business.
-

2. Market Segmentation & Growth Potential

K-Means Clustering Insights:

- *3 Key Market Segments Identified:*
 1. High-Market-Share States (e.g., Maharashtra, Tamil Nadu) → *Saturated market, tough competition.*
 2. Emerging Growth States (e.g., Gujarat, Telangana) → *Ideal for new startups.*
 3. Low-Adoption States (e.g., Bihar, Assam) → *Long-term investment needed, weak infrastructure.*
- **Insight:**
 - *Best strategy is to enter "Emerging Growth States" where competition is low but demand is rising.*

3. Factors That Influence EV Sales the Most

Random Forest Regressor Analysis:

- Charging Infrastructure is the Biggest Factor (50%)
 - Market Share has a moderate impact (28%)
 - Production Capacity has the lowest effect (21%)
- **Insight:**
 - Investing in fast-charging stations is CRUCIAL for EV adoption.
 - Even in areas with high production capacity, sales suffer if charging stations are lacking.

4. Future EV Sales Predictions

Exponential Smoothing Forecasting:

- Sales are expected to increase by ~20-30% in the next 5 years in emerging markets.
- States like Karnataka, Gujarat, and Telangana show the highest potential for growth.
- Slower growth in states with poor EV infrastructure.

Insight:

- If entering the market now, focus on early-mover advantage in high-growth states.
 - Start with cities that have an existing EV-friendly policy & infrastructure.
-

5. Competitive Landscape & Market Gaps

Competitor Analysis (Bengaluru & Morbi):

- **Bengaluru:** Ather (16.5% share), Mahindra Electric (13.88%) → Competition is high but fragmented.
- **Morbi:** Ajanta Manufacturing (9.14% share) → Fewer competitors, more room for a new player.

- Insight:

- Avoid competing directly with established brands.
 - Differentiate by offering unique features like long battery life, fast charging, or cost-efficient models.
-

Final Business Recommendations

Where to Start?

- ◆ *Bengaluru* (For premium EVs, tech-driven innovation)
- ◆ *Morbi* (For mass-market, affordable EVs)

What to Invest In?

- ◆ *Charging Infrastructure* (Essential for long-term success)
- ◆ *R&D for Battery Efficiency* (Biggest cost factor in EVs)

How to Differentiate?

- ◆ Affordable EV models with fast charging
 - ◆ Focus on commercial EVs (delivery, taxi, logistics)
-

Final Words :- India's EV market is growing rapidly, and the right strategy can help new startups succeed. By targeting the right states, focusing on infrastructure, and choosing the right market segment, an EV startup can establish itself successfully.

Que - 3 :- How will you improve upon the Market Segmentation Project given additional time & some budget to purchase data? (in terms of Datasets collection - name what columns points you will search for & what additional ML models you would like to try)

Ans:-

How to Improve the Market Segmentation Project

If given more time and budget, I would enhance the project by:

1. Expanding the dataset with more relevant features.
 2. Using advanced ML models for deeper insights.
-

1. Improved Dataset Collection

Currently, the dataset includes State, Place, Market Share, Charging Stations, Annual Sales, and Production Capacity.

To improve accuracy, I would purchase and collect data with additional columns:

Additional Data Columns to Collect

Column Name	Why It's Important?
EV Adoption Rate (%)	Measures how quickly EVs are replacing traditional vehicles.
Electricity Cost (per kWh)	Affects the running cost of EVs and adoption likelihood.
Government Incentives & Policies	Helps identify states with subsidies and tax benefits for EV startups.
Population Density	High-density areas may have more EV demand.
Road Infrastructure Quality	Poor infrastructure can slow down EV adoption.
Average Income per Household	Higher incomes may indicate more demand for premium EVs.
EV Charging Cost per Session	Affects user adoption rate in public charging stations.

Competitor Pricing Data	Helps in pricing strategy for an EV startup.
Customer Preference Surveys	Understands what features EV buyers want (e.g., range, charging speed).
Traffic Congestion Levels	Higher congestion can drive demand for compact and electric vehicles.

Where to Collect Data?

- Government Reports (e.g., NITI Aayog, Ministry of Road Transport)
 - EV Charging Network Providers (Tata Power, ChargePoint)
 - EV Sales Reports from SIAM (Society of Indian Automobile Manufacturers)
 - Survey Data from Consumers
-

2. Advanced ML Models to Improve Insights

ML Model	Purpose & Improvement
Hierarchical Clustering	Unlike K-Means, it doesn't require specifying the number of clusters in advance. It helps in better segmentation.
XGBoost Regressor	More accurate feature importance analysis to determine sales drivers.
Prophet Time Series Model	Better future EV sales forecasting with trend & seasonal components.
Association Rule Learning	Identifies hidden patterns (e.g., "Areas with low charging stations have low sales").
Neural Networks (ANNs)	Can model non-linear relationships between EV adoption and various features.

How It Helps?

- **More refined market segmentation** → Identify untapped business opportunities.
 - **More accurate EV sales forecasting** → Helps in investment planning.
 - **Better feature importance analysis** → Focus investment on the right factors (e.g., subsidies, charging infra).
-

Final Improvements with Extra Budget & Time

- ◆ *Collect richer, more detailed data on EV market conditions.*
- ◆ *Use advanced ML models for deeper insights and more precise forecasting.*
- ◆ *Improve segmentation with unsupervised learning models.*

Que – 4 : What is the estimated Market Size for your Market Domain (non-segmented) in Numbers?

Ans :-

Estimated Market Size for the EV Domain (Non-Segmented)

Based on our analysis, we estimate the total market size for the Indian EV sector using the following approach:

1. Total Annual EV Sales in India (Current Market Size)

- According to our dataset, the total annual EV sales across all states = 1.2 million units (1,200,000 EVs/year).
- This includes *electric 2-wheelers, 3-wheelers, and 4-wheelers.*
- **Revenue per EV:** ₹1.2 lakh - ₹20 lakh (varies by category).

Estimated Revenue of Indian EV Market (2024)

Market Size = Total Sales × Average EV Price

- ◆ **India's total EV market is approximately ₹6 lakh crore (~\$72 billion USD) annually.**
-

2. Future Market Growth (Projected Size by 2030)

- **Growth Rate (CAGR):** 35% (Government & industry estimates).
 - **Projected Sales by 2030:** ~10 million EVs/year.
 - **Projected Market Size by 2030:** ₹40 - ₹50 lakh crore (~\$480B - \$600B).
-

3. Market Share for a New EV Startup

If a new EV startup captures even **0.5% market share**, potential revenue:

$$0.5 \% \times ₹6 \text{ Lakh Crore} = ₹30,000$$

This shows **huge growth potential for a new entrant in the Indian EV sector.**

Final Conclusion :-

Best Places to Start an EV Startup

1. Bengaluru, Karnataka –

- Low market share (~5%)
- High **charging infrastructure** (~1,000+ stations)
- Strong **annual sales potential** (400,000+ units)

2. Morbi, Gujarat –

- Moderate market share (~9%)
- Good **charging infrastructure** (~1,140 stations)
- Strong **sales demand** (~246,000 units)

Recommendation

- **Bengaluru** is the best place due to high EV adoption potential, existing infrastructure, and strong demand.
- **Morbi, Gujarat** is also a good alternative with growing demand.

Github Link :-[https://github.com/tanmaydumbre/EV_Market_Analysis]