Data Analysis Of EV Sales In India 2014-2024

Salil Panwar

I Help Businesses Scale Up With Google Ads Meta Ads Bing Ads & Data Analytics| End To End Marketing| SA360 Display Search Video Shopping Ads Certified| Certified Data Analyst| SQL| Tableau| Excel| Power BI| Rstudio

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As a part of my online 4 month internship at **Unified Mentor Private Limited**, I have been given various datasets to perform data analysis, data manipulation and data visualization on them.

As a part of this project, I have chosen to perform these tasks on the Electric Vehicle Sales by State in India for the years 2014-2024. I analyzed, cleaned, manipulated, modelled and visualized over 96,800 rows of data across 8 columns in a dataset. Various data pivots were created in order to dive deeper into the insights of the data provided.

The data analysis, modelling, manipulation tasks were primarily carried out using **Microsoft SQL Server**. I also used **Microsoft Copilot** for debugging my query for errors, showcasing my skills as a Data Analyst as well as Artificial Intelligence prompt query writing.

The data visualization was performed using **Power BI** as my primary go to tool in order to explore and validate my skills in the requisite visualization tool. I have been using primarily Tableau for data visualization till this project, in order to build a strong foundation for my future endeavors in complex data visualization using other tools like Microsoft Power-BI and Google Looker Studio.

Methodology

- Data Cleaning, Preparation and Manipulation:- Microsoft SQL Server was used primarily for verification of data integrity, accuracy, cleaning, preparing and manipulating data for further analysis. All the null values were removed as a part of the data cleaning process. The schema of all the columns of data was checked in order to process the data for further manipulation.

```
SELECT *
FROM [ev_sales_india_project].dbo.[ev_sales_statewise_india]
```

109 % No issues found Ln: 13 Ch: 7 SPC CRLF

Results Messages

	years	month_name	dated	state_name	vehicle_class	vehicle_category	vehicle_type	ev_sales_quantity
96812	2023	dec	2023-12-01	Delhi	MAXI CAB	Others	Others	0
96813	2023	dec	2023-12-01	Delhi	M-CYCLE/SCOOTER	2-Wheelers	2W_Personal	5380
96814	2023	dec	2023-12-01	Delhi	M-CYCLE/SCOOTER-WITH SIDE...	2-Wheelers	2W_Personal	0
96815	2023	dec	2023-12-01	Delhi	MOPED	2-Wheelers	2W_Personal	0
96816	2023	dec	2023-12-01	Delhi	MOTOR CAB	4-Wheelers	4W_Shared	84
96817	2023	dec	2023-12-01	Delhi	MOTOR CAR	4-Wheelers	4W_Personal	727
96818	2023	dec	2023-12-01	Delhi	THREE WHEELER (GOODS)	3-Wheelers	3W_Goods	681
96819	2023	dec	2023-12-01	Delhi	THREE WHEELER (PASSENGER)	3-Wheelers	3W_Shared	8
96820	2023	dec	2023-12-01	Goa	ADAPTED VEHICLE	Others	Others	0
96821	2023	dec	2023-12-01	Goa	AGRICULTURAL TRACTOR	Others	Others	0
96822	2023	dec	2023-12-01	Goa	BUS	Bus	Bus	6
96823	2023	dec	2023-12-01	Goa	CONSTRUCTION EQUIPMENT V...	Others	Others	0
96824	2023	dec	2023-12-01	Goa	GOODS CARRIER	Others	Others	4
96825	2023	dec	2023-12-01	Goa	HEARSES	Others	Others	0
96826	2023	dec	2023-12-01	Goa	MAXI CAB	Others	Others	0
96827	2023	dec	2023-12-01	Goa	M-CYCLE/SCOOTER	2-Wheelers	2W_Personal	799
96828	2023	dec	2023-12-01	Goa	MOTOR CAB	4-Wheelers	4W_Shared	0
96829	2023	dec	2023-12-01	Goa	MOTOR CAR	4-Wheelers	4W_Personal	71
96830	2023	dec	2023-12-01	Goa	MOTOR CYCLE/SCOOTER-SIDE...	Others	Others	0
96831	2023	dec	2023-12-01	Goa	MOTOR CYCLE/SCOOTER-USE...	2-Wheelers	2W_Shared	0
96832	2023	dec	2023-12-01	Goa	THREE WHEELER (GOODS)	3-Wheelers	3W_Goods	0
96833	2023	dec	2023-12-01	Goa	THREE WHEELER (PASSENGER)	3-Wheelers	3W_Shared	2
96834	2023	dec	2023-12-01	Goa	THREE WHEELER (PERSONAL)	3-Wheelers	3W_Personal	1
96835	2023	dec	2023-12-01	Andaman & Ni...	CONSTRUCTION EQUIPMENT V...	Others	Others	0
96836	2023	dec	2023-12-01	Andaman & Ni...	GOODS CARRIER	Others	Others	0
96837	2023	dec	2023-12-01	Andaman & Ni...	MAXI CAB	Others	Others	0

Data Cleaning

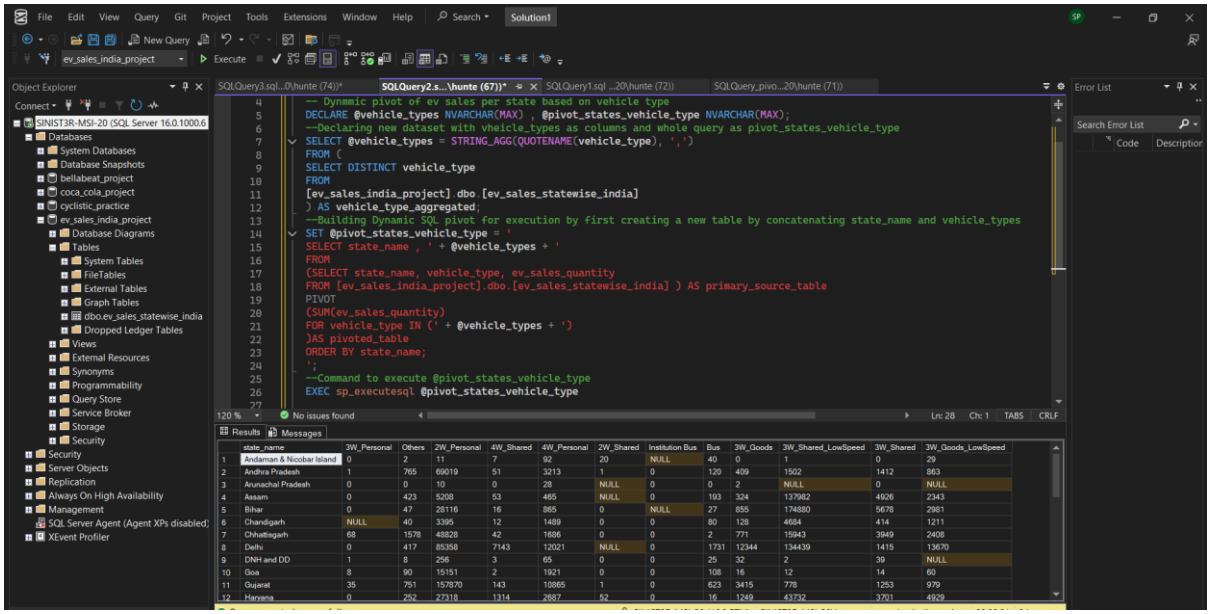
- During the process of data preparation, I noticed that few of the column headers were clashing with the syntaxes of Microsoft SQL. In order to avoid this I renamed all the clashing column headers and also ran data validation for all NULL and missing values.
- For my Data Manipulation, I found out that the data provided is large, vague and not insightful for data visualization, presentation, recommendations. In order to make the data more readily available for easier and quicker analysis, I went ahead and performed data pivoting operations of various kind to gain more insights. During this process I had a question in my mind "What if the dataset gets updated later on? How can I automate this process based on data being updated automatically at backend?" . Hence, I discovered Dynamic SQL for data calling which pulls and pivots the data in real time automatically, regardless of the data being updated any number of time.

```sql
SELECT *
FROM [ev_sales_india_project].dbo.[ev_sales_statewise_india]

--1 pivoting by vehicle class and total sales code
SELECT
state_name,
vehicle_class,
SUM (ev_sales_quantity) AS total_ev_sales_per_state
FROM [ev_sales_india_project].dbo.[ev_sales_statewise_india]
GROUP BY state_name, vehicle_class
ORDER BY state_name ASC, total_ev_sales_per_state DESC
--1 pivoting by vehicle class and total sales code
--2 pivoting based on sale per year for each state
SELECT *
FROM(
SELECT years, state_name, ev_sales_quantity
FROM [ev_sales_india_project].dbo.[ev_sales_statewise_india]
) AS source_table
PIVOT(
SUM(ev_sales_quantity)
FOR years IN ([2014],[2015],[2016],[2017],[2018],[2019],[2020],[2021],[2022],[2023])
)AS pivot_table
ORDER BY state_name;
--2 pivoting based on sale per year for each state
--3 pivoting based on sum of all vehicles per vehicle categories per state
SELECT *
FROM(
SELECT state_name, vehicle_category, ev_sales_quantity
FROM[ev_sales_india_project].dbo.[ev_sales_statewise_india]
) AS source_table
PIVOT(
SUM(ev_sales_quantity)
FOR vehicle_category IN ([Others],[Bus],[2-Wheelers],[4-Wheelers],[3-Wheelers])
) AS pivot_vehiclecategory_evsalesquantity
ORDER BY state_name;

--3 pivoting based on sum of all vehicles per vehicle categories per state

--4 Dynamic pivot of ev sales by state per year
```

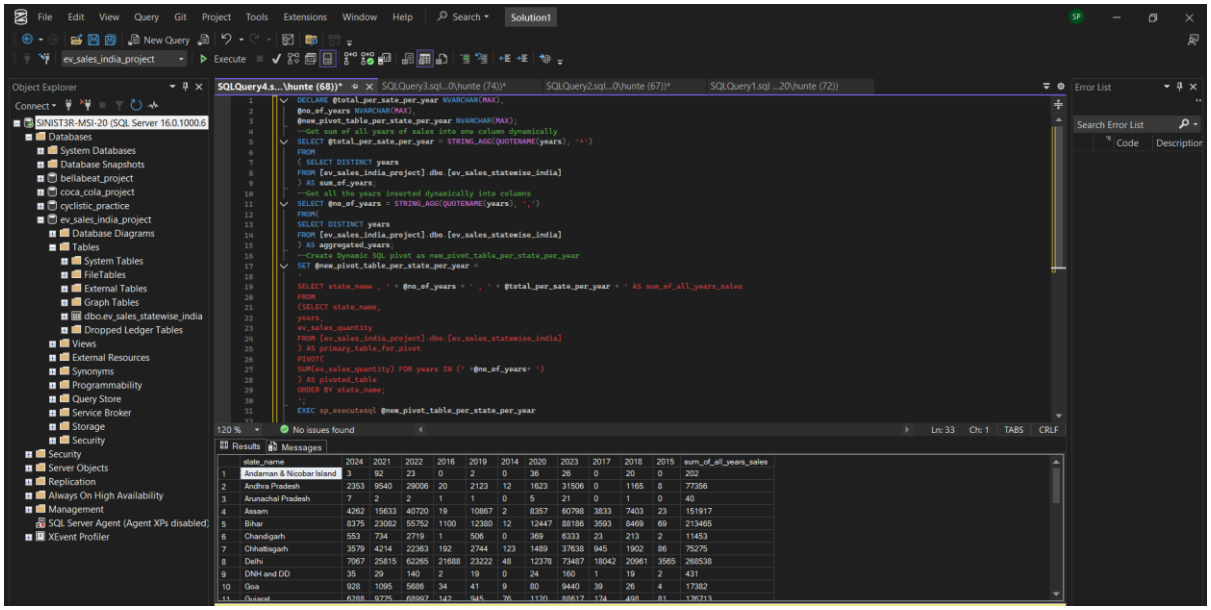
```sql

DECLARE @total_per_sate_per_year NVARCHAR(MAX),
@no_of_years NVARCHAR(MAX),
@new_pivot_table_per_state_per_year NVARCHAR(MAX);
--Get sum of all years of sales into one column dynamically
SELECT @total_per_sate_per_year = STRING_AGG(QUOTENAME(years), '+')
FROM
( SELECT DISTINCT years
FROM [ev_sales_india_project].dbo.[ev_sales_statewise_india]
) AS sum_of_years;
--Get all the years inserted dynamically into columns
SELECT @no_of_years = STRING_AGG(QUOTENAME(years), ',')
FROM(
SELECT DISTINCT years
FROM [ev_sales_india_project].dbo.[ev_sales_statewise_india]
) AS aggregated_years;
--Create Dynamic SQL pivot as new_pivot_table_per_state_per_year
SET @new_pivot_table_per_state_per_year =
'
SELECT state_name , ' + @no_of_years + ' , ' + @total_per_sate_per_year + ' AS sum_of_all_years_sales
FROM
(SELECT state_name,
years,
ev_sales_quantity
FROM [ev_sales_india_project].dbo.[ev_sales_statewise_india]
) AS primary_table_for_pivot
PIVOT(
SUM(ev_sales_quantity) FOR years IN (' +@no_of_years+ ')
) AS pivoted_table
ORDER BY state_name;
';
EXEC sp_executesql @new_pivot_table_per_state_per_year

--4 Dynamic pivot of ev sales by state per year

--5 Dynamic pivot of ev sales per state per vehicle types
```

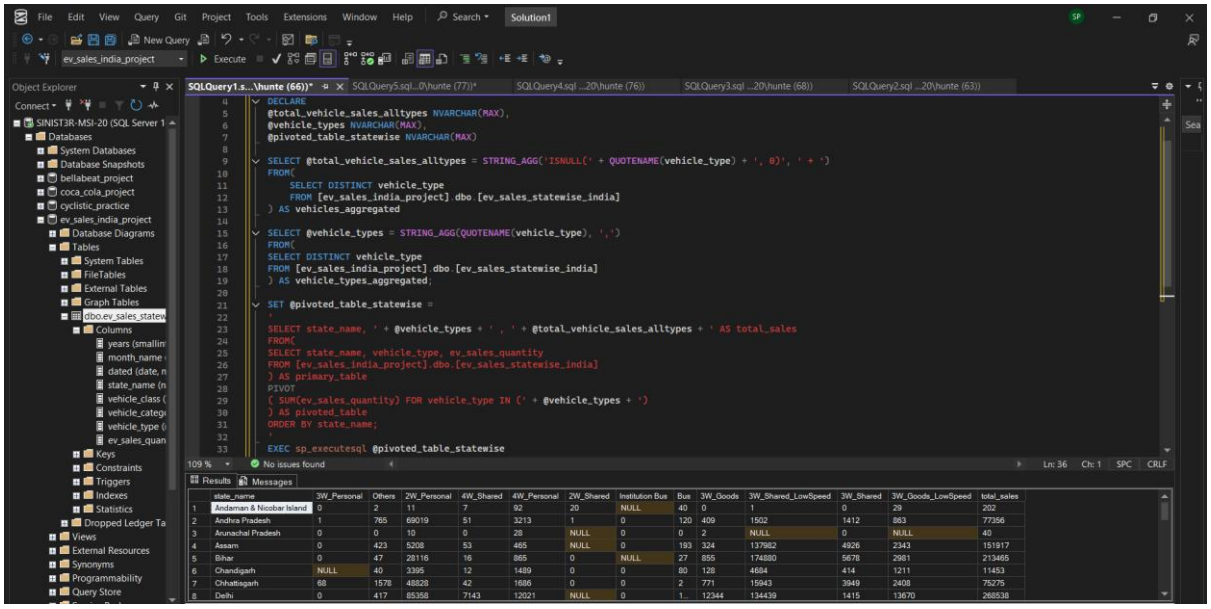
```sql

DECLARE
@total_vehicle_sales_alltypes NVARCHAR(MAX),
@vehicle_types NVARCHAR(MAX),
@pivoted_table_statewise NVARCHAR(MAX)

SELECT @total_vehicle_sales_alltypes = STRING_AGG('ISNULL(' + QUOTENAME(vehicle_type) + ', 0)', ' + ')
FROM(
    SELECT DISTINCT vehicle_type
    FROM [ev_sales_india_project].dbo.[ev_sales_statewise_india]
) AS vehicles_aggregated

SELECT @vehicle_types = STRING_AGG(QUOTENAME(vehicle_type), ',')
FROM(
SELECT DISTINCT vehicle_type
FROM [ev_sales_india_project].dbo.[ev_sales_statewise_india]
) AS vehicle_types_aggregated;

SET @pivoted_table_statewise =
'
SELECT state_name, ' + @vehicle_types + ' , ' + @total_vehicle_sales_alltypes + ' AS total_sales
FROM(
SELECT state_name, vehicle_type, ev_sales_quantity
FROM [ev_sales_india_project].dbo.[ev_sales_statewise_india]
) AS primary_table
PIVOT
( SUM(ev_sales_quantity) FOR vehicle_type IN (' + @vehicle_types + ')
) AS pivoted_table
ORDER BY state_name;
'
EXEC sp_executesql @pivoted_table_statewise

--5 Dynamic pivot of ev sales per state per vehicle types
```

```sql
--6 Dynamic pivot of yearly ev sales based on vehicle category

DECLARE @vehicle_sales_yearly NVARCHAR(MAX) , @total_vehicle_sales NVARCHAR(MAX) , @pivot_table_vehicle_type NVARCHAR(MAX)

SELECT @vehicle_sales_yearly = STRING_AGG(QUOTENAME(years), ',')
FROM
(
SELECT DISTINCT years
FROM [ev_sales_india_project].dbo.ev_sales_statewise_india
) AS years_aggregated_for_pivot;

SELECT @total_vehicle_sales = STRING_AGG(QUOTENAME(years), '+')
FROM
(SELECT DISTINCT years
FROM [ev_sales_india_project].dbo.[ev_sales_statewise_india]
) AS total_years_aggregated

SET @pivot_table_vehicle_type ='
SELECT vehicle_category , ' + @vehicle_sales_yearly + ' , ' + @total_vehicle_sales+ ' AS total_vehicle_sales
FROM
(
SELECT
vehicle_category,
years,
ev_sales_quantity
FROM [ev_sales_india_project].dbo.[ev_sales_statewise_india]
) AS primary_source_table
PIVOT
( SUM(ev_sales_quantity) FOR years IN (' + @vehicle_sales_yearly+ ')
) AS pivoted_table
ORDER BY vehicle_category;
';
EXEC sp_executesql @pivot_table_vehicle_type
--6 Dynamic pivot of yearly ev sales based on vehicle category
```

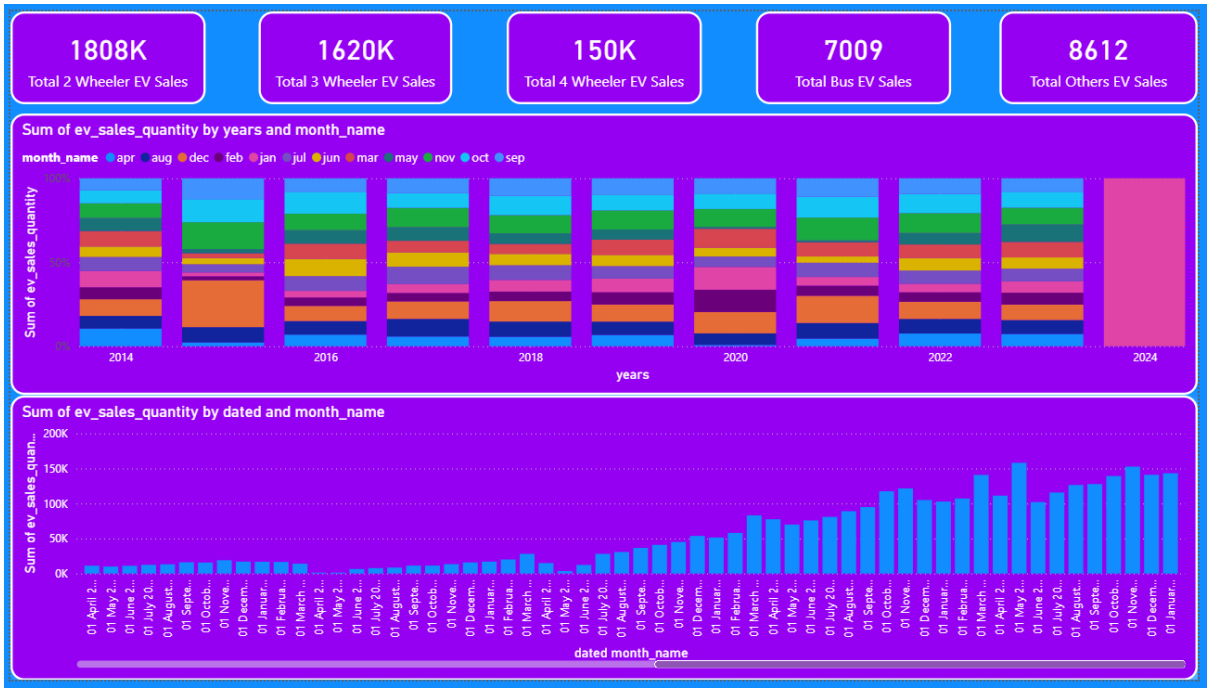


	state_name	3W_Personal	Others	2W_Personal	4W_Shared	4W_Personal	2W_Shared	Institution Bus	Bus	3W_Goods	3W_Shared_LowSpeed	3W_Shared	3W_Goods_LowSpeed
1	Andaman & Nicobar Island	0	2	11	7	92	20	NULL	40	0	1	0	29
2	Andhra Pradesh	1	765	69019	51	3213	1	0	120	409	1502	1412	863
3	Arunachal Pradesh	0	0	10	0	28	NULL	0	0	2	NULL	0	NULL
4	Assam	0	423	5208	53	465	NULL	0	193	324	137982	4926	2343
5	Bihar	0	47	28116	16	865	0	NULL	27	855	174880	5678	2981
6	Chandigarh	NULL	40	3395	12	1489	0	0	80	128	4684	414	1211
7	Chhattisgarh	68	1578	48828	42	1686	0	0	2	771	15943	3949	2408
8	Delhi	0	417	85358	7143	12021	NULL	0	1731	12344	134439	1415	13670
9	DNH and DD	1	8	256	3	65	0	0	25	32	2	39	NULL
10	Goa	8	90	15151	2	1921	0	0	108	16	12	14	60
11	Gujarat	35	751	157870	143	10865	1	0	623	3415	778	1253	979
12	Haryana	0	252	27318	1314	2687	52	0	16	1249	43732	3701	4929





- Data Visualization: PowerBI software was used to transform the various datasets into meaningful and insightful visual representations of data in form of charts, graphs, trend lines for business and financial analysis.



- Scope Of Data: Over10 years of national data state-wise of Electric Vehicles across 96,800 data points and 8 columns we're cleaned, analyzed and manipulated from a financial and business use perspective.

Key Insights:

1. In terms of total electric vehicle per state, Uttar Pradesh has seen the most number of sales, followed by Maharashtra and Karnataka. This shows the confidence of Indian consumers in the electric vehicles.
2. Electric Vehicles are also gaining popularity in many other states which are primarily consisting of Tier-2, Tier-3, Tier-4 cities and rural areas.
3. Two wheeler is the most popular electric vehicle among all types of electric vehicles, showcasing the strong confidence of middle class on the EV initiative and lower carbon emissions.

State which are lagging behind are primarily the one's with a weak road and electricity infrastructure.

Recommendations:

- Invest in building of more EV charging infrastructure across all states and metropolitan cities in order to boost consumer confidence in electric vehicles to push for lower carbon footprint of India.
- Invest in small sized nuclear power stations for all major cities in order to reduce reliance on coal power plants.
- Reduce all forms of taxes on all personal use electric vehicles in order to boost sales among middle class.
- Giving tax benefits to companies manufacturing and selling electric vehicles in India under government supervision for funding of Research and Development department of the private firms.
- Built and increase road connectivity and infrastructure across India to build confidence in potential consumers in rural areas as well in order to boost sales and lower national emissions.

Data Visualization:

You can view all my codes, queries, visuals and spreadsheets on my **GitHub project**.
-Salil Panwar