Project Report

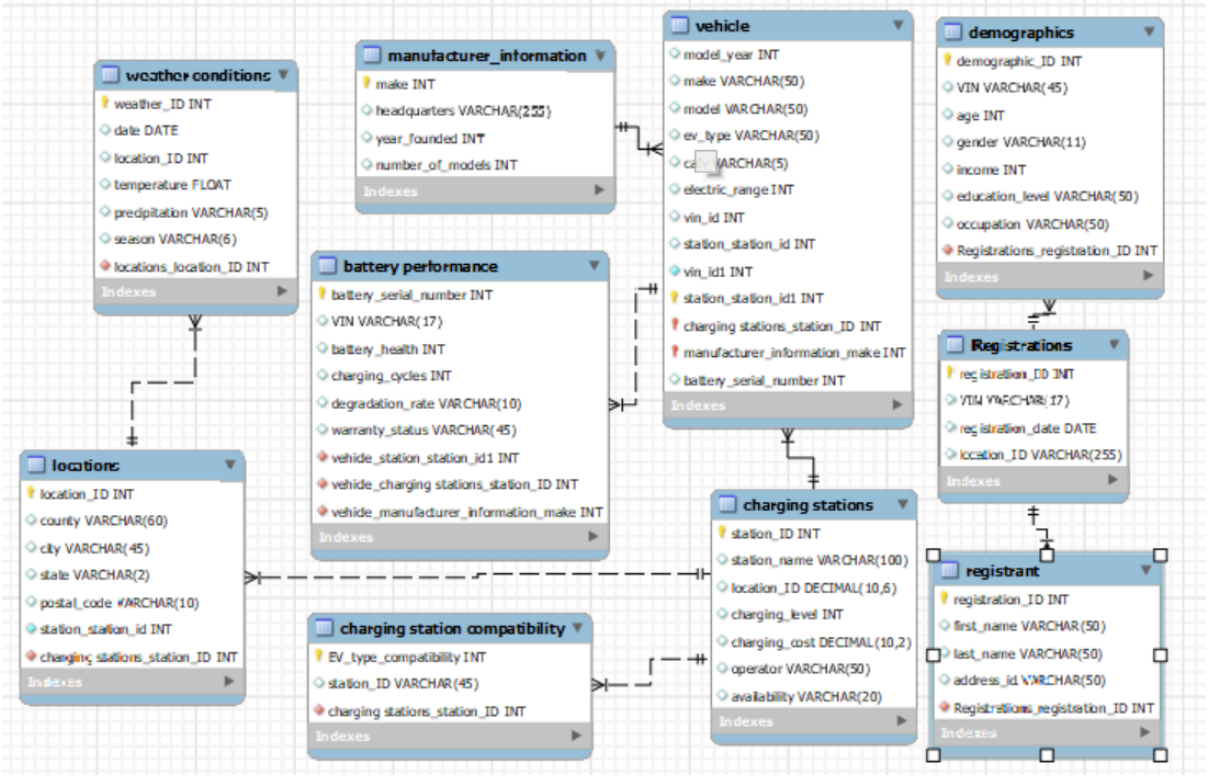
Introduction:

For our project we have decided to use the Electric Vehicle Population dataset. The electric vehicle population in Washington State in the years 2015 to 2022 has given promising perspectives on increasing eco-friendly technology in transportation in the area. Despite not having a gateway to real-time data, we are able to bring about a more general approach to gather and scrutinize such data.

Our group has decided to focus on the Electric Vehicle Population dataset because of the extraordinary and continuous increase in the electric vehicle market. The rapid increase in the electric vehicle market is reshaping the automotive industry today as well as setting the foundation for future transportation and its sustainability.

Database Description:

- Logical Design:



1. Weather Conditions: This table is identified by weather_ID and takes the date, temperature, and precipitation, allowing us to analyze the impact of weather on EV usage.

2. Locations: Holding location_ID as the primary key, it includes data on the county, city, state, and postal code, providing a spatial dimension to our group's analysis.
3. Charging Stations: Identified by station_ID, it details the infrastructure available for EVs, including station name, location coordinates, charging levels, and station availability.
4. Manufacturer Information: With make as the primary key, it offers insights into where EVs are made, the founding year of manufacturers, and the number of models produced, which can be linked to vehicle popularity and adoption rates.
5. Battery Performance: This table, linked to vehicles through VIN, tracks the battery's health and performance, critical for understanding the longevity and reliability of EVs.
6. Demographics: Through demographic_ID, we correlate demographic data with EV ownership, such as age, gender, income, education, and occupation, to discern patterns in EV adoption among different population segments.
7. Vehicle: This is a comprehensive table that contains information about each EV, including model year, make, model, EV type, and CAFV status, which is the backbone of our EV analysis.
8. Registrations: This is a comprehensive table that contains information about each EV, including model year, make, model, EV type, and CAFV status, which is the backbone of our EV analysis.
9. Charging Station Compatibility: This table links EV types with compatible charging stations, indicated by ev_type_compatibility_ID, providing data on the adaptability and accessibility of charging infrastructure.
10. Registrant: Capturing owner details through registration_ID, it gives us a personal dimension to vehicle data, enhancing our understanding of who is driving EVs.

- Sample Data:

  When creating our data our group kept quite a number of things in mind. We considered the vehicle year range and decided to keep the timeframe from 2015 to 2022. Geographical focus was another key consideration since the majority of the data is focused on Washington State and we have decided to add data from a few other states as well. Remaining key considerations were popular EV models within the state, exclusion of discounted models, and balanced demographic representation.

  Physical Database:

  - Address:

county	city	state	postalcode
Los Angeles	Los Angeles	CA	90001
King	Seattle	WA	98101
Cook	Chicago	IL	60601
Maricopa	Phoenix	AZ	85001
Harris	Houston	TX	77001
San Diego	San Diego	CA	92101
Orange	Anaheim	CA	92801
Miami-Dade	Miami	FL	33101
Clark	Las Vegas	NV	89101
Dallas	Dallas	TX	75201
Queens	New York	NY	11430
King	Bellevue	WA	98004
Suffolk	Boston	MA	02101
Wayne	Detroit	MI	48201
Multnomah	Portland	OR	97201

  - Station:

station_id	station_name	Location	operator	evtype_compatibility	availability
2	EcoPower Hub	456 Wind Ave, Portland, OR	EcoStation	BEV	Business Hours
5	Renewable Charge Spot	202 Eco Rd, San Diego, CA	RenewStation	BEV, PHEV	Business Hours
8	Sustainable Energy Station	505 Green St, Las Vegas, NV	SustainCharge	BEV	Business Hours
10	Eco-Friendly Charging	707 Eco Park Rd, Denver, CO	EcoFriendly	BEV	Business Hours
12	NextGen Charging Station	909 Future Way, Chicago, IL	NextGenCharge	BEV	Business Hours
14	GreenTech Charging Point	1111 Tech Rd, Boston, MA	GreenTech	BEV	Business Hours
1	Green Energy Point	123 Solar Way, Seattle, WA	GreenCharge	BEV, PHEV	24/7
3	City Center Fast Charge	789 Main St, San Francisco, CA	CityCharge	BEV	24/7
4	Urban Electric Stop	101 Battery Blvd, Los Angeles, CA	UrbanCharge	PHEV	24/7
6	Tech City Charge Point	303 Silicon St, San Jose, CA	TechCharge	BEV	24/7
7	E-Mobility Station	404 Electra Ln, Sacramento, CA	EMobility	PHEV	24/7
9	Future Fuel Hub	606 Innovation Ave, Phoenix, AZ	FutureFuel	BEV, PHEV	24/7
11	Clean Energy Charge	808 Renewal Dr, Austin, TX	CleanEnergy	PHEV	24/7
13	Electric Avenue Station	1010 Power Pl, Miami, FL	ElectricAve	BEV, PHEV	24/7
15	Eco Power Spot	1212 Sustainable St, New York, NY	EcoPower	PHEV	24/7
	NULL	NULL	NULL	NULL	NULL

- Vehicle:

model_year	make	model	ev_type	cafv	electric_range
2022	Tesla	Model S	BEV	Yes	402
2021	Chevrolet	Bolt EV	BEV	No	259
2020	Nissan	Leaf	BEV	Yes	226
2019	BMW	i3	BEV	No	153
2018	Ford	Mustang Mach-E	BEV	Yes	300
2017	Audi	e-tron	BEV	No	204
2016	Hyundai	Kona Electric	BEV	Yes	258
2015	Kia	Niro EV	BEV	No	239
2023	Porsche	Taycan	BEV	Yes	227
2022	Volkswagen	ID.4	BEV	No	250
2021	Jaguar	I-PACE	BEV	Yes	234
2020	Mercedes-...	EQC	BEV	No	220
2019	Lucid	Air	BEV	Yes	517
2018	Rivian	R1T	BEV	No	314
2017	Polestar	2	BEV	Yes	275

- Vin:

id	VIN
1	1HGCM82633A004352
2	1HGCM82633A004353
3	1HGCM82633A004354
4	1HGCM82633A004355
5	1HGCM82633A004356
6	1HGCM82633A004357
7	1HGCM82633A004358
8	1HGCM82633A004359
9	1HGCM82633A004360
10	1HGCM82633A004361
11	1HGCM82633A004362
12	1HGCM82633A004363
13	1HGCM82633A004364
14	1HGCM82633A004365
15	1HGCM82633A004366
NULL	NULL

- Charging:

charging_level	charging_cost
Level 1	0.00
Level 1	0.50
Level 1	1.00
Level 2	1.50
Level 2	2.00
Level 2	2.50
Level 3	3.00
Level 3	3.50
Level 3	4.00
Fast Charge	4.50
Fast Charge	5.00
Fast Charge	5.50
Super Charge	6.00
Super Charge	6.50
Super Charge	7.00

- Battery Performance:

VIN	BatterySerialNumber	BatteryHealth	ChargingCycles	DegradationRate	WarrantyStatus
1HGCM82633A004352	BAT001	95.00	150	5.00	Active
1HGCM82633A004353	BAT002	90.00	200	10.00	Active
1HGCM82633A004354	BAT003	85.00	250	15.00	Active
1HGCM82633A004355	BAT004	80.00	300	20.00	Expired
1HGCM82633A004356	BAT005	75.00	350	25.00	Expired
1HGCM82633A004357	BAT006	70.00	400	30.00	Expired
1HGCM82633A004358	BAT007	65.00	450	35.00	Expired
1HGCM82633A004359	BAT008	60.00	500	40.00	Expired
1HGCM82633A004360	BAT009	55.00	550	45.00	Expired
1HGCM82633A004361	BAT010	50.00	600	50.00	Expired
1HGCM82633A004362	BAT011	95.00	100	5.00	Active
1HGCM82633A004363	BAT012	90.00	150	10.00	Active
1HGCM82633A004364	BAT013	85.00	200	15.00	Active
1HGCM82633A004365	BAT014	80.00	250	20.00	Expired
1HGCM82633A004366	BAT015	75.00	300	25.00	Expired
NULL	NULL	NULL	NULL	NULL	NULL

- Demographics:

DemographicID	Age	Gender	Income	EducationLevel	Occupation
1	34	Female	75000.00	Bachelors	Engineer
2	28	Male	68000.00	Masters	Teacher
3	45	Female	85000.00	PhD	Scientist
4	38	Male	92000.00	Masters	Architect
5	30	Female	78000.00	Bachelors	Nurse
6	50	Male	100000.00	PhD	Consultant
7	26	Female	56000.00	Bachelors	Graphic Designer
8	41	Male	89000.00	Masters	Software Developer
9	35	Female	67000.00	Masters	HR Manager
10	48	Male	110000.00	PhD	Physician
11	29	Female	73000.00	Bachelors	Accountant
12	53	Male	95000.00	Masters	Engineer
13	31	Female	64000.00	Masters	Social Worker
14	47	Male	87000.00	Bachelors	Lawyer
15	39	Female	81000.00	PhD	Chemist
NULL	NULL	NULL	NULL	NULL	NULL

- Manufacturer:

ManufacturerID	Make	Headquarters	YearFounded	NumberOfModels
1	Tesla	Palo Alto, California, USA	2003	5
2	Toyota	Toyota City, Japan	1937	20
3	Ford	Dearborn, Michigan, USA	1903	15
4	BMW	Munich, Germany	1916	18
5	Chevrolet	Detroit, Michigan, USA	1911	10
6	Nissan	Yokohama, Japan	1933	23
7	Hyundai	Seoul, South Korea	1967	14
8	Audi	Ingolstadt, Germany	1909	12
9	Volkswagen	Wolfsburg, Germany	1937	21
10	Honda	Tokyo, Japan	1948	19
11	Kia	Seoul, South Korea	1944	16
12	Porsche	Stuttgart, Germany	1931	8
13	Mercedes-...	Stuttgart, Germany	1926	17
14	Peugeot	Paris, France	1810	10
15	Renault	Boulogne-Billancourt, Fr...	1899	15
NULL	NULL	NULL	NULL	NULL

- Registration:

RegistrationID	VIN	RegistrationDate	FirstName	LastName	Address	County	City	State	PostalCode	LegislativeDistrict
1	1HGCM82633A004352	2021-01-15	John	Doe	123 Main St	Los Angeles	Los Angeles	CA	90001	34
2	1HGCM82633A004353	2021-02-20	Jane	Smith	456 Elm St	King	Seattle	WA	98101	47
3	1HGCM82633A004354	2021-03-25	Alice	Johnson	789 Oak St	Cook	Chicago	IL	60601	13
4	1HGCM82633A004355	2021-04-30	Bob	Brown	159 Pine Ln	Maricopa	Phoenix	AZ	85001	22
5	1HGCM82633A004356	2021-05-15	Emily	White	264 Maple Ave	Harris	Houston	TX	77001	18
6	1HGCM82633A004357	2021-06-10	Michael	Green	321 Birch Blvd	Miami-Dade	Miami	FL	33101	27
7	1HGCM82633A004358	2021-07-20	Chloe	Adams	587 Cedar St	Clark	Las Vegas	NV	89101	5
8	1HGCM82633A004359	2021-08-30	Daniel	Miller	834 Elm Dr	Wayne	Detroit	MI	48201	16
9	1HGCM82633A004360	2021-09-15	Sophia	Lee	902 Walnut St	Queens	New York	NY	11430	11
10	1HGCM82633A004361	2021-10-22	Oscar	Davis	1010 Cherry Ct	San Diego	San Diego	CA	92101	39
11	1HGCM82633A004362	2021-11-05	Lily	Wilson	77 Oak Ln	Suffolk	Boston	MA	02101	8
12	1HGCM82633A004363	2021-12-10	Mason	Martinez	66 Pine Rd	Orange	Anaheim	CA	92801	45
13	1HGCM82633A004364	2022-01-06	Emma	Garcia	555 Cedar Pl	Shelby	Memphis	TN	38103	31
14	1HGCM82633A004365	2022-02-18	Lucas	Rodriguez	333 Spruce Way	Franklin	Columbus	OH	43215	19
15	1HGCM82633A004366	2022-03-12	Olivia	Lopez	444 Birch Rd	Philadelphia	Philadelphia	PA	19120	26

- Weather Conditions:

WeatherID	WeatherDate	City	Temperature	Precipitation	Season
1	2021-01-15	Seattle	5.00	50.00	Winter
2	2021-02-20	Phoenix	15.00	5.00	Winter
3	2021-03-25	Chicago	10.00	20.00	Spring
4	2021-04-30	Los Angeles	20.00	0.00	Spring
5	2021-05-15	Houston	25.00	10.00	Spring
6	2021-06-10	Miami	30.00	20.00	Summer
7	2021-07-20	Las Vegas	40.00	0.00	Summer
8	2021-08-30	Detroit	25.00	30.00	Summer
9	2021-09-15	New York	20.00	40.00	Fall
10	2021-10-22	San Diego	18.00	10.00	Fall
11	2021-11-05	Boston	10.00	50.00	Fall
12	2021-12-10	Anaheim	15.00	5.00	Winter
13	2022-01-06	Memphis	5.00	60.00	Winter
14	2022-02-18	Columbus	-5.00	70.00	Winter
15	2022-03-12	Philadelphia	8.00	20.00	Spring

Database Ethics Considerations:

- Data Privacy and Security: We prioritized the protection of individual privacy by implementing rigorous data anonymization techniques, ensuring that personal identifiers such as vehicle registration numbers were securely obfuscated.
- Representation and Bias Mitigation: Our sample data was carefully curated to provide a balanced representation of various demographics, thereby minimizing potential biases in our analysis and ensuring a comprehensive understanding of electric vehicle adoption across diverse population segments.
- Ethical Sourcing and Fair Use: We adhered to strict guidelines for ethical sourcing, ensuring that our data, though hypothetical, reflected realistic scenarios without infringing on any proprietary or confidential information.
- Transparency in Data Handling: Our methodology was characterized by transparency. Each step, from data collection to analysis, was documented and justified, providing clarity on how conclusions were drawn.
- Ethical Application of Data: We were mindful of the potential implications of our findings. Our analyses and projections were conducted with an ethical responsibility, ensuring that they do not lead to misconceptions or misuse of data.

Lessons Learned:

- Focused Project Scope: Initially, the project aimed to analyze electric vehicle populations broadly. However, we then narrowed the focus to specifically electric vehicles, leading to a more manageable and targeted approach.
- Adaptability and Flexibility: Our ability to adapt to changing project requirements was crucial. We expanded our scope to include a variety of brands and attributes, demonstrating our flexibility and dynamic approach to project management.
- Data Ethics and Privacy: Our project gave significant attention to ethical considerations, especially regarding demographic data. We recognized the importance of maintaining data privacy and ensuring the ethical use of information, which became fundamental to our project's methodology.
- Collaboration and Communication: The project highlighted the importance of strong team collaboration and communication. Successfully coordinating various project aspects was key to our progress and overall success.

Potential Future Work:

- Geographical Expansion of Database: We are considering expanding our database to encompass electric vehicles in other states or even on a nationwide scale. This would significantly enhance the comprehensiveness and relevance of our data.
- Incorporating Diverse Data Sets: We see the potential for including additional years of data and more diverse data sources. Doing this would enrich our analysis and provide more nuanced insights.
- Real-Time Data Analysis: A future goal is to integrate real-time data feeds. This would allow our database to provide up-to-date, dynamic analysis, making it more valuable for current assessments.
- Cross-Application of Database Model: We see potential in applying our developed database model to other domains or vehicle types. This would not only broaden the utility of our project but also demonstrate the versatility of our approach.

Project code:

```
-- Query 1: Select all records from the Vehicles table
SELECT * FROM vehicle;

-- Query 2: Select all charging stations available 24/7
SELECT * FROM station WHERE Availability = '24/7';

-- Query 3: Alternative: Count of registrations by state
SELECT State, COUNT(*) as RegistrationCount
FROM registration
GROUP BY State;

-- Query 4: Average Battery Health for Each VIN
SELECT VIN, AVG(BatteryHealth) as AvgBatteryHealth
FROM batteryperformance
GROUP BY VIN;

-- Query 5: Select weather conditions for 'Seattle' during 'Winter'
SELECT * FROM weatherconditions WHERE City = 'Seattle' AND Season =
'Winter';

-- Query 6: Count of Registrations by City
SELECT City, COUNT(*) as RegistrationCount
FROM registration
GROUP BY City;
```

```sql
-- Query 7: Total Number of Charging Stations by Operator
SELECT operator, COUNT(*) as TotalStations
FROM station
GROUP BY operator;

-- Query 8: List of Vehicles with Electric Range Greater Than 250 Miles
SELECT model_year, make, model, electric_range
FROM vehicle
WHERE electric_range > 250
ORDER BY electric_range DESC;

-- Query 9: Average Charging Cost by Charging Level
SELECT charging_level, AVG(charging_cost) as AvgCost
FROM charging
GROUP BY charging_level;

-- Query 10: Distribution of Vehicle Makes in a Specific State (e.g.,
California)
SELECT v.make, COUNT(*) as Count
FROM registration r
JOIN vehicle v ON r.VIN = v.VIN
WHERE r.State = 'CA' -- Replace 'CA' with the desired state
GROUP BY v.make;

-- Query 11: Total Electric Range by Vehicle Make
SELECT make, SUM(electric_range) as TotalElectricRange
FROM vehicle
GROUP BY make;

-- Query 12: Average Age of Vehicle Owners in Each City
SELECT r.City, AVG(d.Age) as AvgOwnerAge
FROM registration r
JOIN demographics d ON r.RegistrationID = d.DemographicID
GROUP BY r.City;

-- Query 12: Vehicles with Battery Health Above Average
SELECT VIN
FROM batteryperformance
WHERE BatteryHealth > (SELECT AVG(BatteryHealth) FROM batteryperformance);

-- Query 13: Count of Registrations per County and City
SELECT County, City, COUNT(*) as RegistrationCount
FROM registration
GROUP BY County, City;


-- Views --
```

```sql
CREATE VIEW View_TotalStationsByOperator AS
SELECT operator, COUNT(*) as TotalStations
FROM station
GROUP BY operator;
SELECT * FROM View_TotalStationsByOperator;

CREATE VIEW View_VehiclesOver250Miles AS
SELECT model_year, make, model, electric_range
FROM vehicle
WHERE electric_range > 250
ORDER BY electric_range DESC;
SELECT * FROM View_VehiclesOver250Miles;

CREATE VIEW View_AvgBatteryHealthByVIN AS
SELECT VIN, AVG(BatteryHealth) as AvgBatteryHealth
FROM batteryperformance
GROUP BY VIN;

CREATE VIEW View_RegistrationCountByState AS
SELECT State, COUNT(*) as RegistrationCount
FROM registration
GROUP BY State;

CREATE VIEW View_AvgChargingCostByLevel AS
SELECT charging_level, AVG(charging_cost) as AvgCost
FROM charging
GROUP BY charging_level;

SELECT * FROM View_AvgBatteryHealthByVIN;
SELECT * FROM View_RegistrationCountByState;
SELECT * FROM View_AvgChargingCostByLevel;
```