Final Project Assignment: Interactive Data Visualization and Storytelling

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1. **Introduction And Background:**

   This project aims to examine how vehicles perform and their impact on the environment and energy usage. The reason for choosing this topic is the increased emphasis on sustainability and the importance of knowing how vehicle design affects fuel usage and emissions. As climate change and environmental protection become more prominent issues, it is crucial to find ways to encourage the use of energy-efficient transportation options.

   Goals:

   Through this project, we aim to:

   - Assess how vehicles impact the environment through their fuel consumption and CO2 emissions.
   - Evaluate the energy efficiency of various vehicle models and types.
   - Investigate how vehicle characteristics (like engine size, cylinders, and transmission) affect fuel efficiency.
   - Offer insights into how vehicle design can impact environmental sustainability and energy conservation.

   Benefit:

   This project will give important information for policymakers, car manufacturers, and consumers to make educated choices about vehicle selection and environmental responsibility. By understanding the factors that affect vehicle performance and environmental impact, stakeholders will be able to make better decisions.

1. **Datasets:**
   Dataset 1: Vehicle Performance Dataset

   Source: The dataset is published by Natural Resources Canada and is available through the Government of Canada's open data portal. The data collection is likely conducted by Natural Resources Canada or a related department within the Canadian government.

Funding Source: The funding source for the data collection is not explicitly mentioned but is likely supported by government funding allocated for environmental research and energy efficiency initiatives.

Variables:

- Model year: The year designated by the manufacturer for the vehicle model.
- Make: The manufacturer of the vehicle.
- Model: The specific model name of the vehicle.
- Vehicle class: Classification of the vehicle based on interior volume for cars and gross vehicle weight rating for light trucks.
- Engine size (L): Total displacement of all cylinders in litres.
- Cylinders: Number of engine cylinders.
- Transmission: Type of transmission and number of gears/speeds.
- Fuel type: Type of fuel used to power the vehicle.
- Fuel Consumption City (L/100 km): City fuel consumption rating in litres per 100 kilometres.
- Fuel Consumption Hwy (L/100 km): Highway fuel consumption rating in litres per 100 kilometres.
- Fuel Consumption Comb (L/100 km): Combined fuel consumption rating in litres per 100 kilometres.
- Fuel Consumption Comb (mpg): Combined fuel consumption rating expressed in miles per imperial gallon.
- CO2 emissions (g/km): Tailpipe emissions of carbon dioxide in grams per kilometre.
- CO2 rating: Vehicle's tailpipe emissions of carbon dioxide rated on a scale from 1 (worst) to 10 (best).
- Smog rating: Vehicle's tailpipe emissions of smog-forming pollutants rated on a scale from 1 (worst) to 10 (best).
- Vehicle Category: Classification of the vehicle based on its characteristics and intended use.

Utility and Limitations:
Utility: This dataset provides comprehensive information on vehicle performance metrics, including fuel consumption, CO2 emissions, and emissions ratings. It will enable us to analyze the environmental impact and energy efficiency of different vehicle models and classes.

Dataset Link: https://open.canada.ca/data/en/dataset/98f1a129-f628-4ce4-b24d-6f16bf24dd64

Dataset 2: CO2 Emissions Dataset

Source: The dataset is sourced from Kaggle, a platform for data science and machine learning enthusiasts. The specific origin of the data collection is not provided in the dataset description.

Variables:

- Make: The manufacturer of the vehicle.
- Model: The specific model name of the vehicle.
- Vehicle Class: Classification of the vehicle based on its characteristics.
- Engine Size(L): Total displacement of all cylinders in litres.
- Cylinders: Number of engine cylinders.
- Transmission: Type of transmission.
- Fuel Type: Type of fuel used to power the vehicle.
- Fuel Consumption City (L/100 km): City fuel consumption rating in litres per 100 kilometres.
- Fuel Consumption Hwy (L/100 km): Highway fuel consumption rating in litres per 100 kilometres.
- Fuel Consumption Comb (L/100 km): Combined fuel consumption rating in litres per 100 kilometres.
- Fuel Consumption Comb (mpg): Combined fuel consumption rating expressed in miles per gallon.
- CO2 Emissions(g/km): Tailpipe emissions of carbon dioxide in grams per kilometre.

Utility and Limitations:

Utility: This dataset provides information on CO2 emissions and fuel consumption for a variety of vehicle models. It will allow us to analyze the environmental impact of different vehicles and compare their emissions performance.

Limitations: The dataset may lack comprehensive coverage of all vehicle models, and the origin of the data collection is unspecified. Additionally, it may not include additional performance metrics such as smog ratings or vehicle categories.

Dataset Link: https://www.kaggle.com/datasets/anirudhduraimohan/c02-emmision

Decision:

After considering the project objectives of analyzing vehicle performance metrics to evaluate their environmental impact and energy efficiency, it has been determined that Dataset 1: Vehicle Performance Dataset is the better choice. This dataset offers a more extensive range of information on vehicle performance metrics such as CO2 emissions, CO2 ratings, smog ratings, and vehicle categories, which are more in line with the project goals.

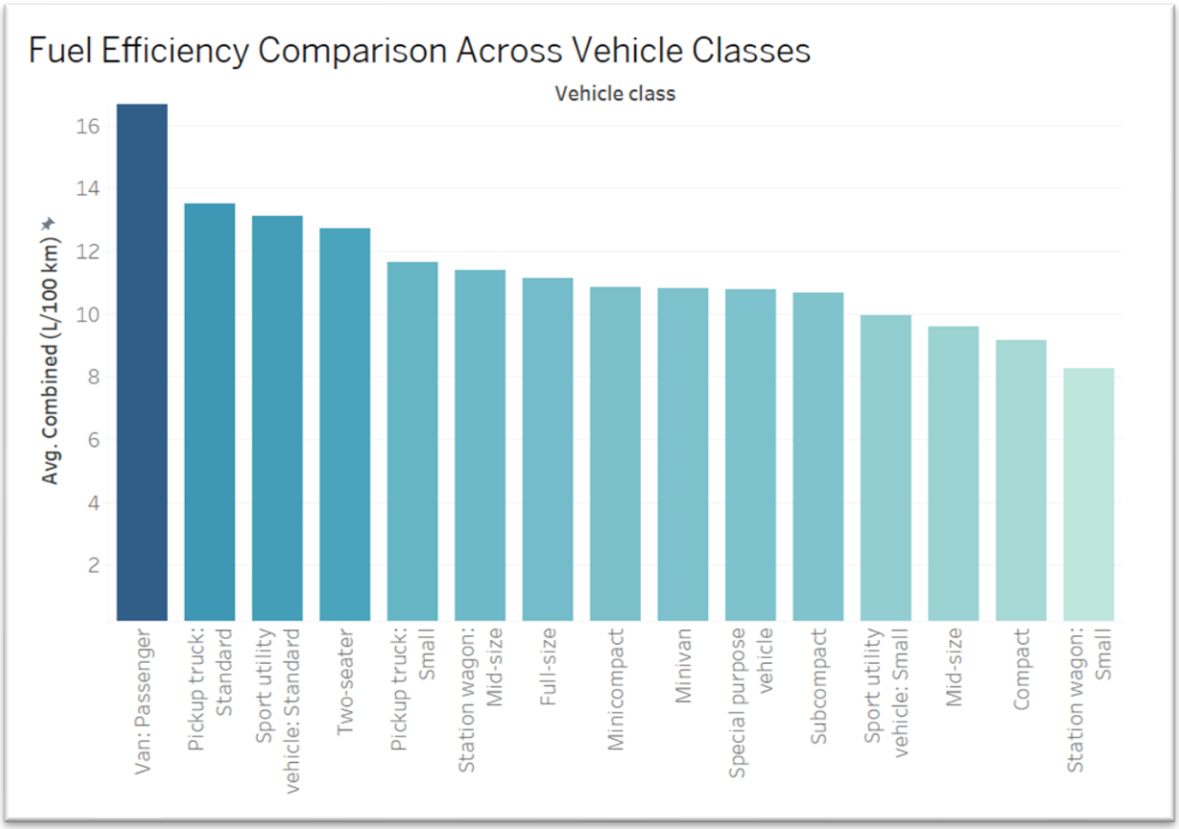
As a result, Dataset 2: CO2 Emissions Dataset should be declined in favour of Dataset 1: Vehicle Performance Dataset.

Reason for Rejection:

Dataset 2 provides some data on CO2 emissions, but it doesn't include detailed information on vehicle performance metrics like fuel consumption, CO2 ratings, and smog ratings. On the other hand, Dataset 1 has a wider range of variables related to vehicle performance, allowing for a more thorough analysis of environmental impact and energy efficiency.

3.Data Story:

How does the fuel efficiency of various vehicle classes differ, and what insights can be gained to inform decision-making processes related to vehicle selection and transportation planning?



Analysis:

- Variables: The variables included in the analysis are vehicle class, average fuel consumption per 100 kilometres (L/100 km), and vehicle make and model.

- Units/Categories: Fuel consumption is measured in litres per 100 kilometres (L/100 km). Vehicle classes represent different categories of vehicles, such as minicompact cars, compact cars, mid-size cars, etc.
- Limitations/Definitions: The analysis focuses on average fuel consumption across vehicle classes and may not account for individual variations within each class. Additionally, fuel efficiency can be influenced by factors such as driving conditions, engine size, and vehicle weight.

Insights:

1. Minicompact Cars Lead in Fuel Efficiency:

   Insight: Minicompact cars demonstrate the highest fuel efficiency.

   Relevance: Individuals seeking cost-effective and environmentally friendly transportation options may prioritize minicompact cars based on their superior fuel economy.

2. Specialty Vehicles Lag in Fuel Efficiency:

   Insight: Specialty vehicles, including pickup trucks and SUVs, exhibit the lowest fuel efficiency.

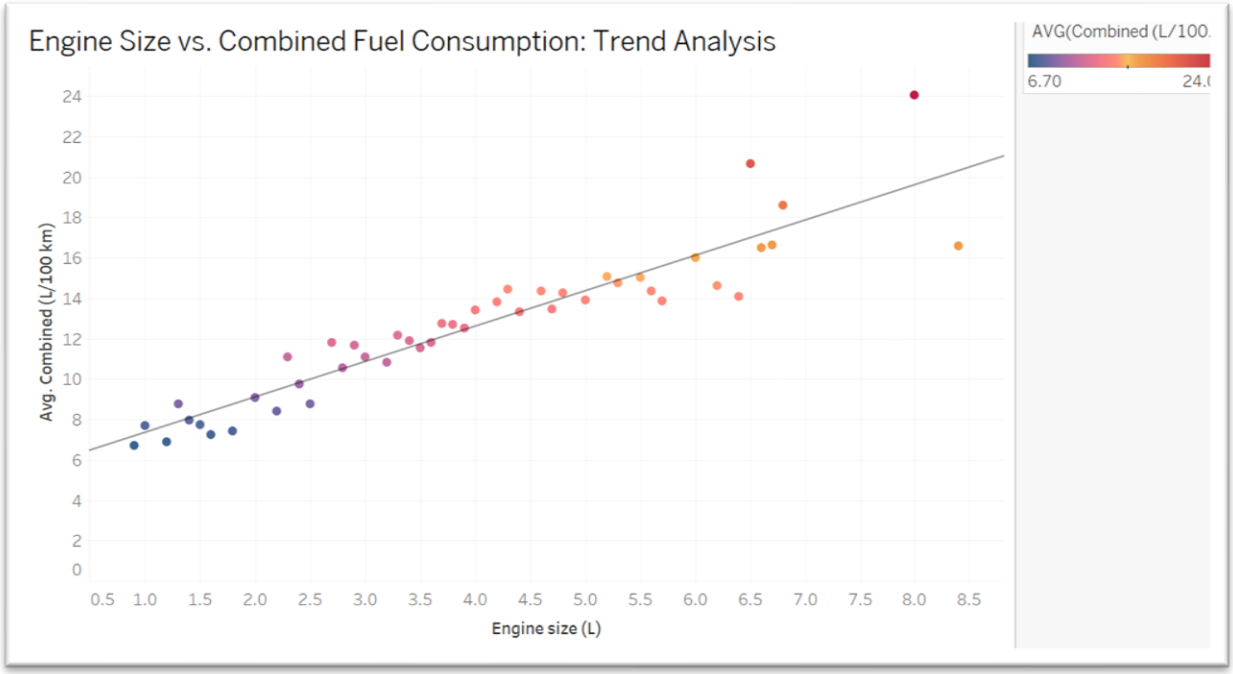
   Relevance: Organizations requiring large vehicles for specific purposes should be aware of the trade-off between size and fuel efficiency when making vehicle procurement decisions.

3. Considerations for Vehicle Selection:

   Insight: Smaller, lighter vehicles tend to be more fuel-efficient than larger, heavier vehicles across different vehicle classes.

   Relevance: Consumers and fleet managers can use this insight to prioritize fuel-efficient options, minimizing fuel costs and environmental impact in their vehicle selections.

How does engine size affect combined fuel consumption in vehicles, and what insights can be gained from analyzing this relationship?



Variables*:* The main variables analysed in the chart are engine size (measured in litres) and combined fuel consumption (measured in litres per 100 kilometre).

Units/Categories:

Engine Size: Engine displacement measured in litres.

Combined Fuel Consumption: The average amount of fuel consumed per 100 kilometres of combined city and highway driving.

Limitations or Definitions:

Combined fuel consumption values are based on standardized testing procedures and may not accurately reflect real-world driving conditions for all vehicles.

Other factors not accounted for in this analysis, such as vehicle weight, aerodynamics, and driving habits, can also influence fuel consumption.

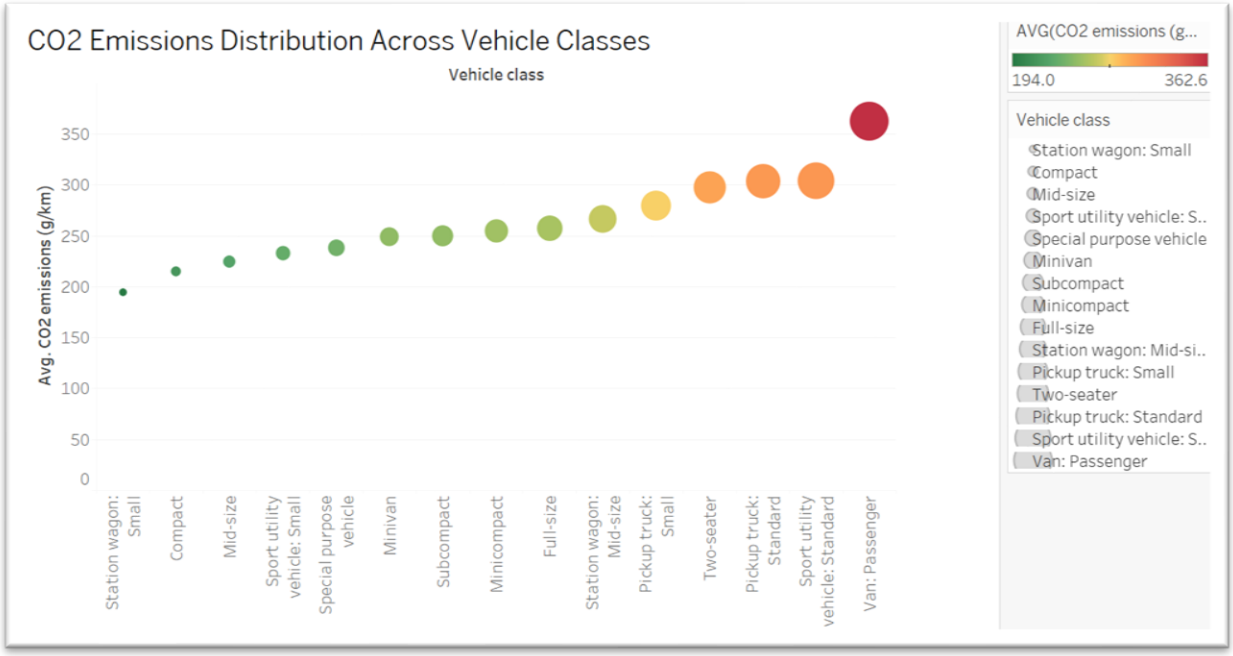
Insights:

The scatter plot reveals a generally positive correlation between engine size and combined fuel consumption, indicating that larger engines tend to consume more fuel.

However, there is considerable variation in fuel consumption within each engine size category, suggesting that other factors also play a significant role in determining fuel efficiency.

The chart highlights the importance of considering multiple factors, such as vehicle weight, aerodynamics, and transmission type, when evaluating a vehicle's fuel efficiency.

How do CO2 emissions vary across different vehicle classes, and what insights can be gained from analyzing these emissions?



Variables

The units/categories represented on the chart are:

X-axis: Vehicle classes

Y-axis: Average CO2 emissions (grams per kilometre)

Analysis:

The chart provides insights into the distribution of CO2 emissions across different vehicle classes:

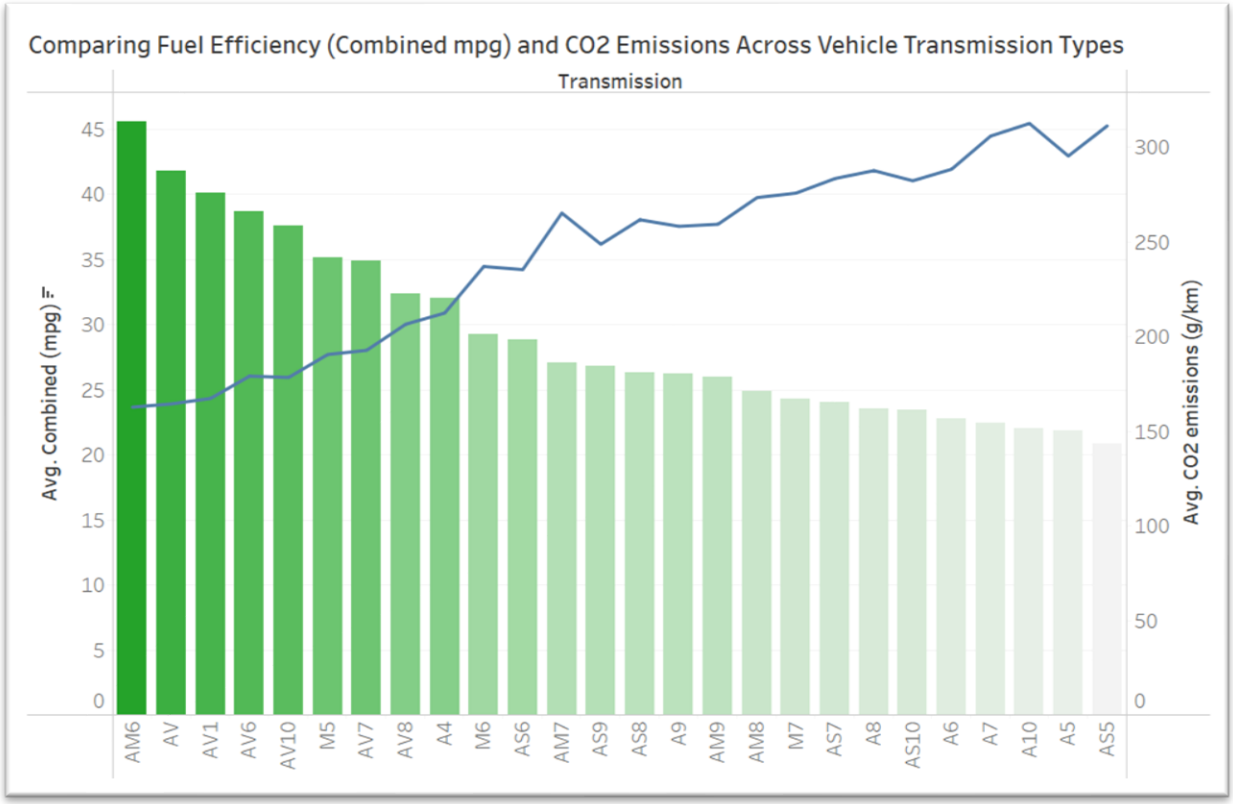
1. SUVs: SUVs exhibit the highest average CO2 emissions, with an average of 362.6 grams per kilometre. This suggests that SUVs, typically larger and heavier vehicles, contribute more to CO2 emissions compared to other vehicle classes.

3. General Trend: The chart highlights a general trend where larger, heavier vehicles tend to emit more CO2 than smaller, lighter vehicles. This underscores the importance of vehicle size and weight in determining CO2 emissions levels.

Insights and Relevance:

Consumer Awareness: Individuals looking to minimize their carbon footprint can use this information to make informed decisions when selecting a vehicle. Choosing smaller, more fuel-efficient models or alternative fuel vehicles can help reduce CO2 emissions.

How do fuel efficiency (combined mpg) and CO2 emissions (g/km) vary across different vehicle transmission types?



Variables:

Fuel Efficiency (Combined mpg): The average number of miles travelledx per gallon of fuel consumed by each vehicle, considering both city and highway driving conditions.

CO2 Emissions (g/km): The amount of carbon dioxide (CO2) emitted by each vehicle per kilometre travelled.

Vehicle Transmission Type: Categorizes vehicles based on their transmission mechanism, such as automatic (AT) or manual (MT).

Insights:

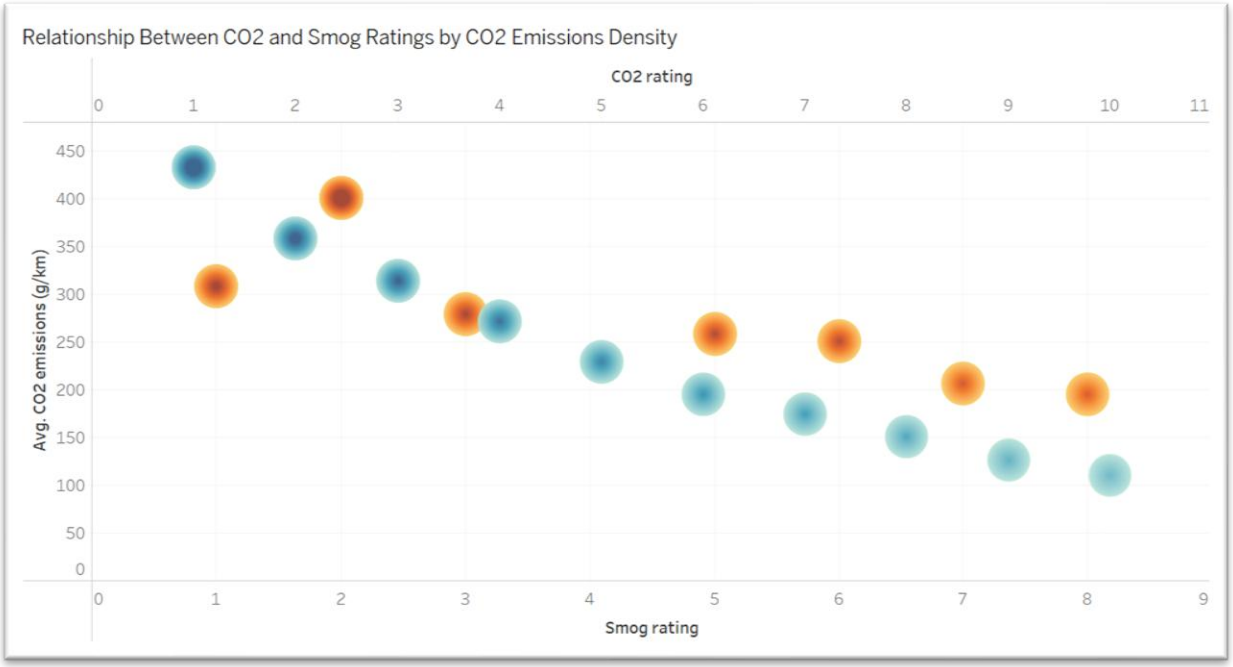
Manual transmissions (MT) generally exhibit higher fuel efficiency compared to automatic transmissions (AT).

Relationship Between CO2 Emissions and Fuel Efficiency: The relationship between CO2 emissions and fuel efficiency is not strictly linear. Other factors, such as the type of fuel used

and the efficiency of the engine, also influence CO2 emissions. For instance, a vehicle with good fuel efficiency may still emit relatively high CO2 if it runs on diesel fuel.

Consumers interested in minimizing their environmental impact may consider vehicles with manual transmissions, as they tend to offer higher fuel efficiency. However, the wide variability in fuel efficiency among automatic transmissions suggests that careful consideration of transmission type and other factors is necessary when making purchasing decisions.

How do CO2 ratings and Smog ratings correlate with each other based on vehicle performance and efficiency?



Variables:

CO2 Rating: A measure of a vehicle's carbon dioxide emissions, typically rated on a scale from 1 to 10, with lower numbers indicating lower emissions.

Smog Rating: A measure of a vehicle's emissions of smog-forming pollutants, usually rated on a scale from 1 to 10, with lower numbers indicating lower emissions.

Analysis:

Lower CO2 Rating, Lower Smog Rating: Vehicles with lower CO2 ratings tend to also have lower Smog ratings. This indicates that they produce fewer pollutants that contribute to

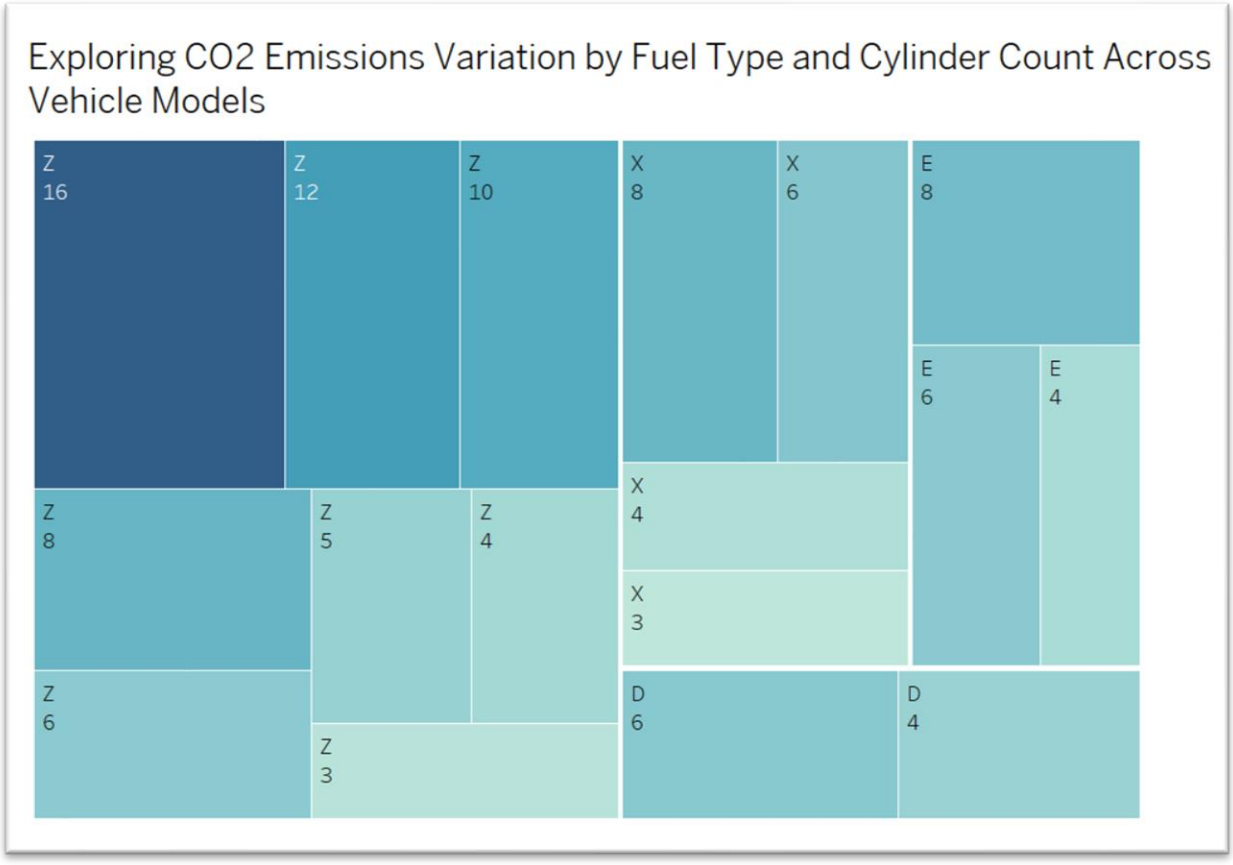
smog formation. These vehicles are likely to include hybrids, electric vehicles, or highly fuel-efficient gasoline-powered vehicles.

Higher CO2 Rating, Higher Smog Rating: Conversely, vehicles with higher CO2 ratings are likely to have higher Smog ratings. This suggests they emit more pollutants that contribute to smog formation. These vehicles may include older models, less efficient engines, or vehicles with larger engines.

Drivers have the opportunity to choose vehicles that match their environmental beliefs and help decrease air pollution by looking at CO2 and Smog ratings.

Although ratings offer helpful guidance, it's important to take into account additional factors like fuel efficiency and driving behaviours when evaluating a vehicle's impact on the environment.

How do CO2 emissions vary based on fuel type and cylinder count across different vehicle models?



Variables:

Fuel Type: Indicates the type of fuel used by the vehicle, such as electric, gasoline, or hybrid.

Cylinder Count: Represents the number of cylinders in the engine of the vehicle.

Analysis:

Fuel Type Significantly Impacts CO2 Emissions: The chart reveals that fuel type is a major determinant of CO2 emissions, with electric vehicles exhibiting the lowest emissions, followed by hybrids and gasoline-powered vehicles.

Cylinder Count and CO2 Emissions: Within each fuel type, there is variation in CO2 emissions based on cylinder count. Generally, vehicles with fewer cylinders tend to have lower emissions, suggesting a potential correlation between engine size and emissions levels.

Within each fuel type category, vehicles with fewer cylinders tend to exhibit lower CO2 emissions, suggesting a potential correlation between engine size and emissions levels.

4. Summary and Conclusions:

Assessment of Environmental Impact and Energy Efficiency:

Our analysis of vehicle performance metrics, including fuel consumption, CO2 emissions, and emissions ratings, has provided valuable insights into how vehicles impact the environment and energy usage. Through our research, we have gained a thorough understanding of how various features of vehicles affect fuel efficiency and emissions.

Our project has revealed key insights:

- Minicompact cars demonstrate superior fuel efficiency, while specialty vehicles like SUVs exhibit the lowest fuel efficiency.
- Engine size significantly influences combined fuel consumption, with larger engines generally consuming more fuel.
- Fuel type plays a crucial role in CO2 emissions, with electric vehicles showing the lowest emissions, followed by hybrids and gasoline-powered vehicles.
- Transmission type impacts fuel efficiency, with manual transmissions generally exhibiting higher fuel efficiency compared to automatic transmissions.

The insights generated have significant implications for stakeholders:

- Policymakers can develop regulations and incentives to promote energy-efficient vehicles and reduce emissions.
- Car manufacturers can prioritize fuel efficiency and environmental sustainability in vehicle design and production.
- Consumers can make informed decisions about vehicle selection based on fuel efficiency, emissions ratings, and environmental impact.

In conclusion, our project has provided valuable insights into the complex relationship between vehicle design, fuel efficiency, and environmental impact. By examining various performance metrics and conducting detailed analysis, we have laid the groundwork for informed decision-making in vehicle selection, transportation planning, and environmental sustainability.