

CO2 Emission Data Analysis Report

1. Data Description

1.2 Source: Kaggle dataset – CO2 Emissions by Vehicles in Canada (7,385 records, 12 attributes).

1.2 Columns:

- - Make – Manufacturer (42 unique values, e.g., Ford, Toyota, BMW)
- - Model – Specific model (2000+ unique models)
- - Vehicle Class – 16 categories (Compact, SUV, Pickup, Station Wagon, etc.)
- - Engine Size (L) – Continuous variable, 1.0L to 8.4L
- - Cylinders – 3 to 12
- - Transmission – 27 types (manual/automatic with different gears)
- - Fuel Type – 5 types (Regular, Premium, Diesel, E85, CNG)
- - Fuel Consumption (City, Hwy, Comb) – Liters/100 km
- - Fuel Consumption (mpg) – Combined, in miles per gallon
- - CO2 Emissions (g/km) – Target variable, 100–400+

1.3 Data Quality:

- - No missing/null values
- - Balanced across classes and manufacturers
- - Reliable and consistent dataset

2. Operations Performed

2.1 Data Cleaning & Exploration

- - Verified dataset shape: (7385, 12)
- - Checked for missing/null values → None found
- - Summarized descriptive statistics for numerical columns
- - Extracted unique values across categorical attributes

2.2 Descriptive Analytics

- - Distribution of CO2 emissions (histograms, boxplots)
- - Vehicle class distribution (bar chart)
- - Transmission types and fuel type frequencies
- - Fuel consumption distributions (city vs highway)

2.3 Relationship Analysis

- - Engine Size vs CO2 emissions (positive correlation)
- - Cylinders vs Fuel Consumption (higher cylinders = higher fuel use)

- - Transmission vs Fuel Economy (modern automatics more efficient)
- - Fuel Type vs CO₂ emissions (gasoline higher, hybrid/alternative lower)

3. Key Insights

3.1 Vehicle & Market Demographics

- - 42 manufacturers, wide representation
- - SUVs and Pickup Trucks dominate dataset (popular in Canadian market)
- - Two-Seaters & Subcompacts least common

3.2 CO₂ Emissions

- - Range: ~100 g/km (hybrids) to 400+ g/km (large SUVs/pickups)
- - Average: ~250 g/km
- - Distribution skewed toward mid-range vehicles

3.3 Fuel Consumption Trends

- - City fuel use higher than highway, reflecting real-world driving
- - Combined consumption: ~4 L/100 km (efficient hybrids) to 20+ L/100 km (large SUVs)
- - Mid-sized cars balance efficiency and performance

3.4 Engine & Transmission

- - Larger engines (higher liters, more cylinders) → higher emissions
- - Vehicles with 6+ cylinders disproportionately contribute to emissions
- - Modern automatic transmissions provide better efficiency

3.5 Fuel Type Insights

- - Regular & Premium gasoline dominate
- - Diesel has moderate presence, while Ethanol (E85) and CNG are rare
- - Alternative fuels (CNG, hybrid, E85) produce lower emissions on average

4. Recommendations

4.1 Environmental Policy

- - Incentivize adoption of hybrids and alternative fuel vehicles
- - Consider stricter emission standards for SUVs and large pickups

4.2 Automotive Industry Strategy

- - Manufacturers can improve efficiency in high-demand SUV and pickup segments
- - Focus on smaller engines + turbocharging instead of high-cylinder designs

4.3 Consumer Awareness

- - Educate buyers on lifetime fuel cost and emissions impact
- - Promote fuel-efficient models in the Canadian market

4.4 Future Analytics Opportunities

- - Predictive modeling for emissions based on engine/fuel configuration
- - Clustering to identify groups of eco-friendly vs. high-emission vehicles
- - Time-series trends (if multi-year data is available) for emission improvements