Project_Proposal_eng

December 12, 2024

0.0.1 1. Topic

0.0.2 *"Analysis of the Correlation Between Regional Electric Vehicle Adoption Rates and PM2.5"*

0.0.3 2. Research Background

A. Health Impacts of PM2.5

- PM2.5 refers to fine particulate matter with a diameter of 2.5 micrometers or less.
- According to OECD data, as of 2020, South Korea's PM2.5 concentration stands at 25.3 μg/m³, over five times worse than Finland, the least polluted country (4.9 μg/m³).
- WHO identifies PM2.5 as a major pollutant linked directly to cardiovascular disease, respiratory illness, and premature death.
- *[Ref]* ***How Much Can EVs Reduce Air Pollution?***

B. Direct Link to Vehicle Emissions

- PM2.5 is a primary pollutant emitted by internal combustion engine vehicles (diesel). By 2050, a projected EV adoption rate of 54% is expected to reduce pollutant emissions by 77% compared to 2016 levels.
- However, while increasing EV adoption is expected to reduce PM2.5 levels, secondary contributors such as tire and brake wear must also be considered.
- *[Ref]* ***The Real Culprits of Vehicle-Related Fine Dust***

C. Policy Priorities

- South Korea's 'Seasonal Fine Dust Management Policy' aims to improve air quality by targeting PM2.5.
- PM2.5, classified as ultrafine dust, has greater adverse effects on human health compared to PM10, making it a key indicator for assessing air quality improvements.
- *[Ref]* ***Lowest PM2.5 Levels Recorded Over the Past Five Years During the 5th Seasonal Management Period***

0.0.4 3. Data Overview

A. Data Sources

- Monthly regional air pollution data for 2023 (Air Korea, https://www.airkorea.or.kr/web/last_amb_hour_data?pMENU_NO=123)
- Regional EV statistics (KEPCO, https://www.data.go.kr/data/15039554/fileData.do)
  - To address timeline inconsistencies, the analysis will use December 2023 data instead of the latest July 2024 data.

B. Key Variables

- Regional EV ownership ratio: {(Number of EVs in a region / Total number of EVs nationwide) * 100}
- Air pollution variables: PM2.5, PM10, NO (vehicle emissions-related), SO (industrial emissions-related), CO (traffic congestion-related).
- Time variable: Monthly data for time-series analysis.

0.0.5 4. Analysis Process

A. Data Preprocessing

- Check for outliers and missing values in the "2023 Monthly Regional Air Pollution Data."
  - Normalize using mean and max values for each pollutant.
  - *[Ref] Data_Analysis.ipynb_Analysis 2*
- Process the "Regional EV Statistics" as of December 31, 2023, to derive basic descriptive statistics.
  - *[Ref] Data_Analysis.ipynb_Analysis 5*

B. Correlation Analysis

- Compute Pearson and Spearman correlations between EV ownership ratios and PM2.5 concentrations.
- Compare air pollution levels between regions with high and low EV adoption rates.

C. Final Visualization

0.0.6 5. Final Visualization Plan

A. Scatter Plot

- *[FINAL] Scatter Plot: EV Ownership Ratio vs. PM2.5*
- Purpose: Visualize the correlation between EV ownership ratios and PM2.5 concentrations.
- Components:
  - X-axis: EV Ownership Ratio (%)
  - Y-axis: PM2.5 Concentration (µg/m³)
  - Each point represents a region, with region names labeled.

B. Composite Heatmap

- *final_ev_pm25_heatmap.html*

- Purpose: Provide a visual representation of regional EV ownership ratios and PM2.5 concentrations.
- Components:
  - PM2.5 Concentration Heatmap:
    - Visualization: Display PM2.5 concentrations for each region using a heatmap (color gradient: red to green).
    - Interpretation: Higher PM2.5 levels are represented in red, while lower levels are shown in green.
  - EV Ownership Ratio Circle Marker:
    - Visualization: Represent regional EV ownership ratios using circle markers' size and opacity.
    - Interpretation: Larger, more opaque circles indicate higher EV ownership ratios.
  - Interactive Pop-Up:
    - Display regional PM2.5 concentrations and EV ownership ratios upon hover.