Analyzing Public Transportation and Traffic Linked to Weather Conditions in Istanbul

OGUZHAN DEMIROZ

Github project link: ozandmrz/made-template

Motivation

Istanbul, with its population of 16 million, faces significant transportation challenges, especially during busy hours due to its dense population. Despite these challenges, Istanbul provides a wide range of transportation options. The abundance of choices leads to constant changes in how people choose to get around.

In this project, we aim to understand the relationship between the transportation choices people make in Istanbul and the weather conditions. Making accurate determinations in this regard can help take preventive measures and make improvements.

Overview On The Public Transport Dataset

In Istanbul, public transportation is categorized into three main branches, and each is evaluated within these categories. An example data table, showing the first five entries for the datasets used in the project for these three types, has been provided.

- `DATE_TIME`: Transition date in YYYY-MM-DD format.
- `transport_type_id`: Mode of transportation used by passengers (1: Highway, 2: Rail, 3: Marine Transportation).
- `number_of_passage`: Number of trips per hour, transfer type, and transportation type.

Public Transport Type 1 Table - Highway:

	DATE_TIME	transport_type_id	number_of_passage
0	2022-10-01 00:00:00	1	18887
1	2022-10-01 01:00:00	1	7885
2	2022-10-01 02:00:00	1	4547
3	2022-10-01 03:00:00	1	2807
4	2022-10-01 04:00:00	1	2465

Public Transport Type 2 Table - Rail:

	DATE_TIME	transport_type_id	number_of_passage
0	2022-10-01 00:00:00	2	17438
1	2022-10-01 01:00:00	2	7422
2	2022-10-01 02:00:00	2	3151
3	2022-10-01 03:00:00	2	1578
4	2022-10-01 04:00:00	2	1052

Public Transport Type 3 Table - Marine Transportation:

	DATE_TIME	transport_type_id	number_of_passage
0	2022-10-01 00:00:00	3	1943
1	2022-10-01 01:00:00	3	331
2	2022-10-01 02:00:00	3	74
3	2022-10-01 03:00:00	3	63
4	2022-10-01 04:00:00	3	35

Overview On The Traffic Density Dataset

Traffic Density Table:

	DATE_TIME	NUMBER_OF_VEHICLES	AVERAGE_SPEED
0	2022-10-01 00:00:00	166586	63.088243
1	2022-10-01 01:00:00	119051	66.163636
2	2022-10-01 02:00:00	83584	67.227687
3	2022-10-01 03:00:00	70154	68.336503
4	2022-10-01 04:00:00	77208	70.502849

Istanbul has an extensive dataset regarding location-based traffic density and vehicle speeds. However, since our project involves a comprehensive study for the entire city of Istanbul, we will use a dataset that includes the first 5 entries along with some groupings in the visuals.

- `DATE_TIME`: Date and time information in YYYY-MM-DD HH24:MI:SS format (hourly).
- `AVERAGE_SPEED`: Average speed (in km/h) for the respective geohash area per hour.
- `NUMBER_OF_VEHICLES`: Number of different vehicles in the relevant geohash area in the given hour.

Overview On The Weather Dataset

The dataset includes hourly weather data for Istanbul, covering various weather parameters within one-hour intervals. The visual presents a sample table of the first 5 rows.

- `temperature_2m`: Air temperature at 2 meters above ground.
- `relative_humidity_2m`: Relative humidity at 2 meters above ground.
- `dew_point_2m`: Dew point temperature at 2 meters above ground.
- `apparent_temperature`: Perceived feels-like temperature combining wind chill factor, relative humidity, and solar radiation.
- `precipitation`: Total precipitation (rain, showers, snow) sum of the preceding hour.
- `rain`: Rain from large-scale weather systems of the preceding hour in millimeters.
- `snowfall`: Snowfall amount of the preceding hour in centimeters.
- `snow_depth`: Snow depth on the ground.
- `wind_speed_10m`: Wind speed at 10 meters above ground.
- `wind_speed_100m`: Wind speed at 100 meters above ground.

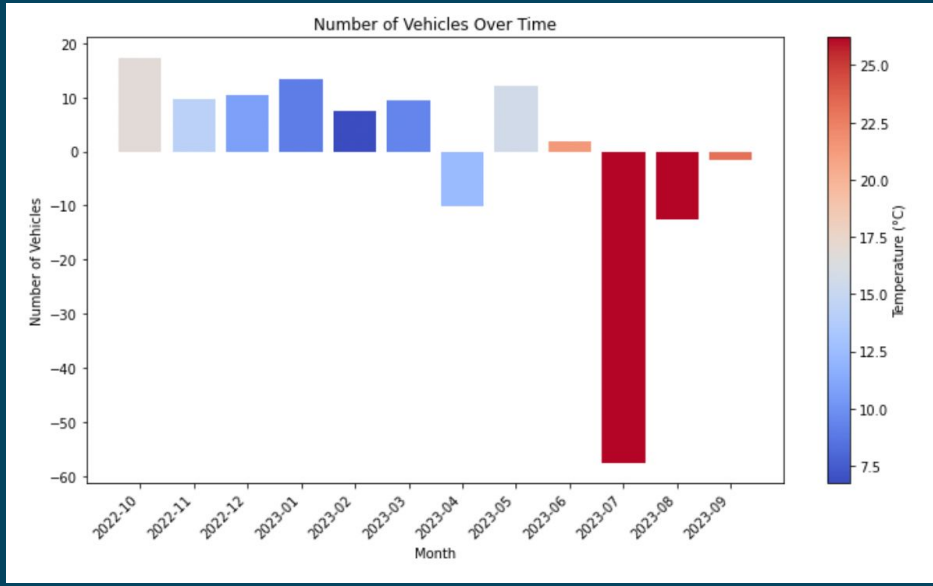
Weather Table:

	time	temperature_2m (°C)	relativehumidity_2m (%)	dewpoint_2m (°C)	apparent_temperature (°C)	precipitation (mm)	rain (mm)	snowfall (cm)	snow_depth (m)	windspeed_10m (km/h)	windspeed_100m (km/h)
0	2022-10-01T00:00	21.4	75	16.8	22.8	0.0	0.0	0.0	0.0	6.7	9.4
1	2022-10-01T01:00	22.5	69	16.5	23.8	0.0	0.0	0.0	0.0	6.4	10.2
2	2022-10-01T02:00	20.3	80	16.6	21.4	0.0	0.0	0.0	0.0	8.0	12.1
3	2022-10-01T03:00	19.2	91	17.7	20.5	0.0	0.0	0.0	0.0	9.9	13.8
4	2022-10-01T04:00	18.2	91	16.7	19.0	0.0	0.0	0.0	0.0	10.7	15.0

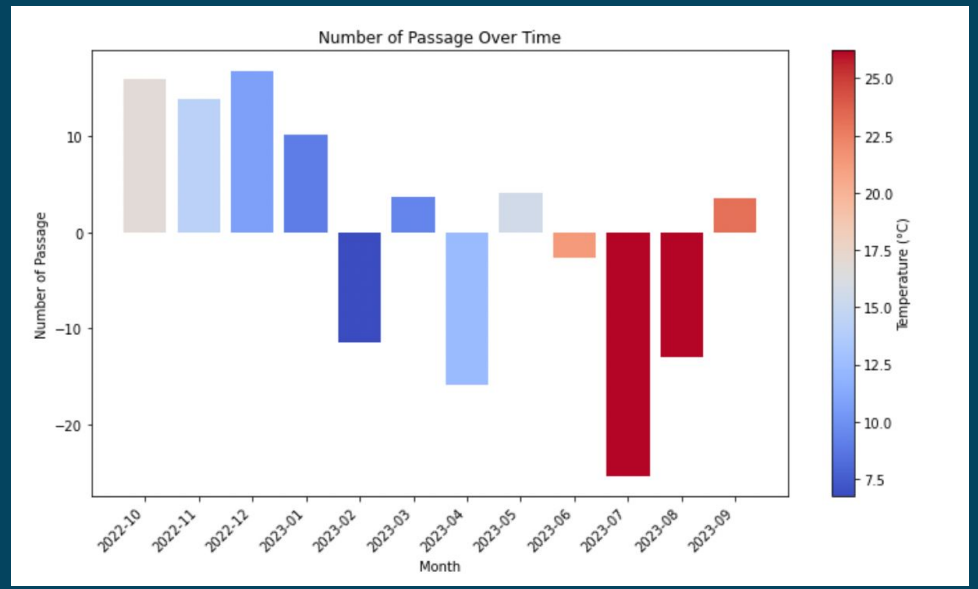
Monthly Analysis of Transportation Type and Temperature

The first graph illustrates the variation of the number of vehicles in traffic relative to the average, while the second one shows the change in the number of individuals using public transportation. Additionally, both graphs include color-coded bars indicating the average temperature for each month.

A decrease in demand is observed when the temperature significantly increases.



A decrease in demand is observed when the temperature significantly increases or **decreases**.

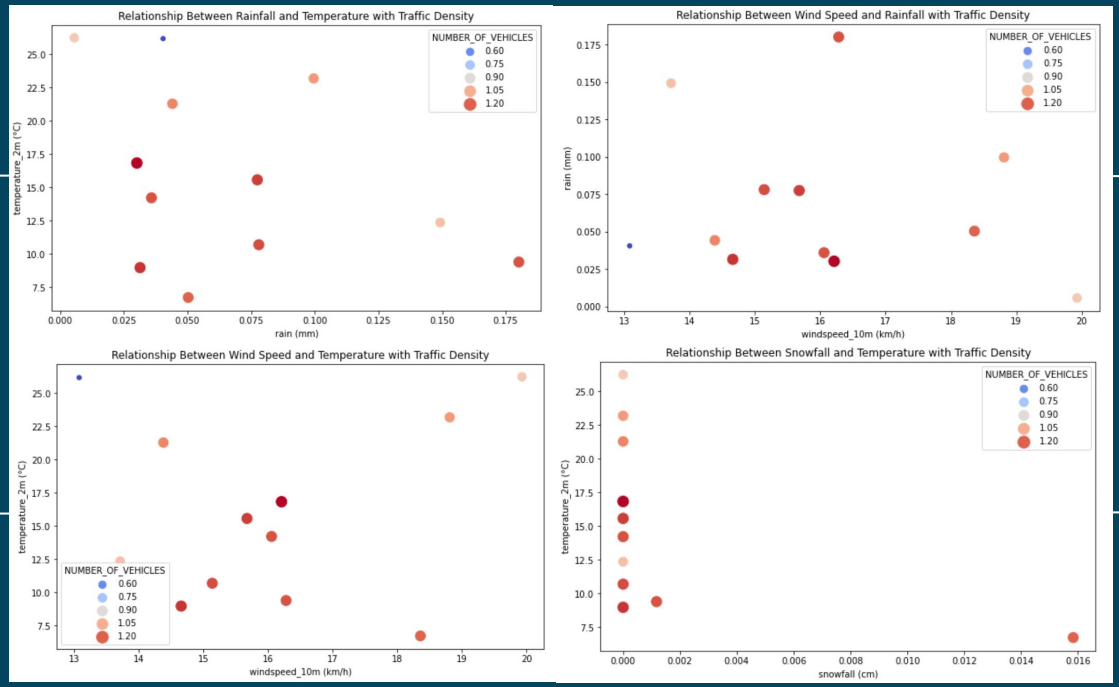


Analysis of Cross-Relationships in Weather Conditions and Transportation (Traffic Density)

Four weather conditions are cross-examined on their effects on Traffic Density in the graph.

In the analysis of monthly temperature, it is observed that, besides the decrease in the number of vehicles as temperature increases, the influence of rainfall and temperature on the number of vehicles is not clearly discernible from the graph.

The graph indicates a concentration of Wind Speed between 14-17, where demand is high. However, outside this range, an increase or decrease in Wind Speed results in a decrease in the number of vehicles. In windy weather, different transportation modes might be preferred, as a decrease in Wind Speed correlates with a decrease in vehicle traffic in similar temperature conditions.



The graph shows a similar concentration of the highest number of vehicles at Wind Speed between 14-17. Interestingly, when Wind Speed is close, the amount of rainfall does not significantly affect the number of vehicles in traffic.

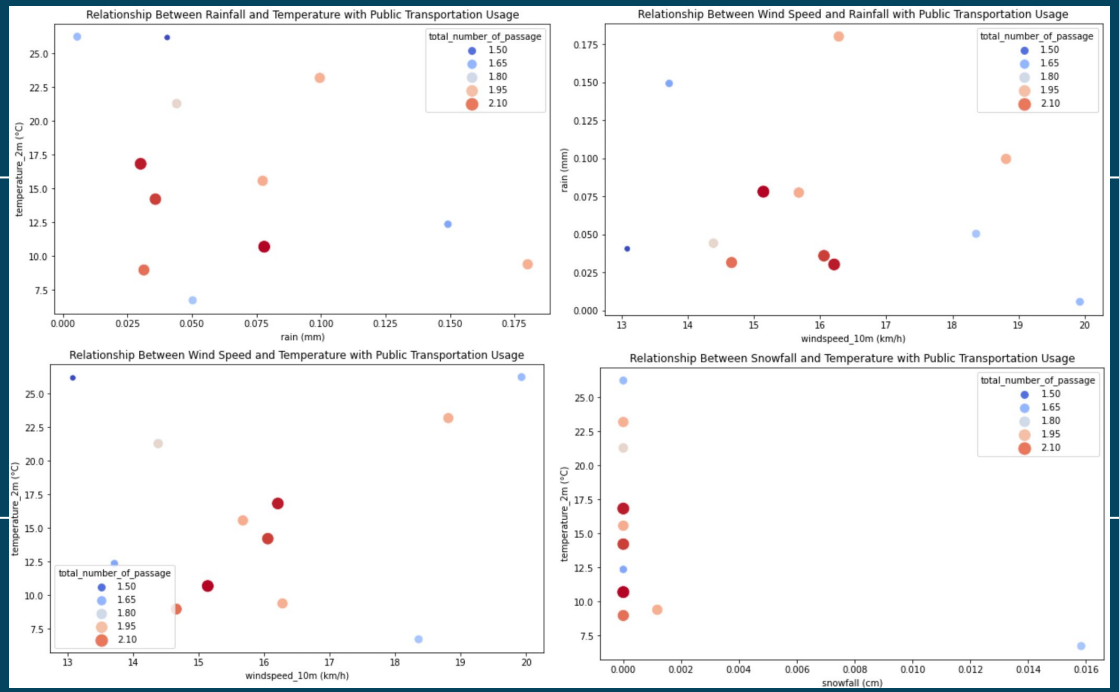
There is a clear natural correlation between Snowfall and Temperature. While the graph may not provide a detailed analysis due to Istanbul's infrequent snowfall, it suggests that during snowfall, the number of vehicles in traffic tends to exceed the average.

Analysis of Cross-Relationships in Weather Conditions and Transportation (Public Transportation)

Four weather conditions are cross-examined on their effects on Public Transportation in the graph.

The graph suggests that demand for public transportation decreases significantly when temperature is very low or high. This aligns with the previous analysis focusing only on temperature. However, analyzing situations where both temperature and rainfall influence demand simultaneously is challenging from monthly data. Further detailed results can be obtained with hourly data or vehicle-specific analyses.

The graph suggests that both Wind Speed and Temperature have peak demand during average values. An increase in temperature results in an increase in demand, while the effect of wind speed is not clear from the graph.



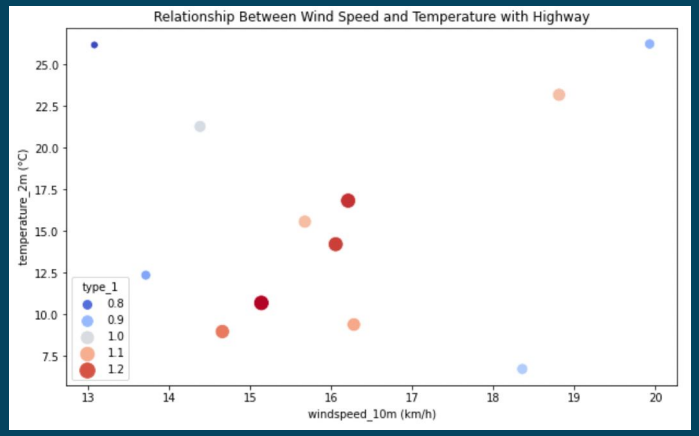
Overall, the graph shows high demand at average values. Additionally, an increase in Rainfall for similar Wind Speed values leads to a decrease in demand.

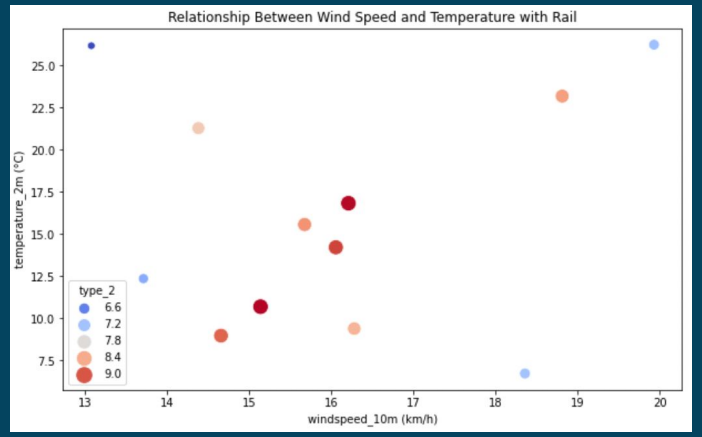
Although there are few instances of snowfall, it is evident from the observed cases that demand is significantly lower during snowy conditions.

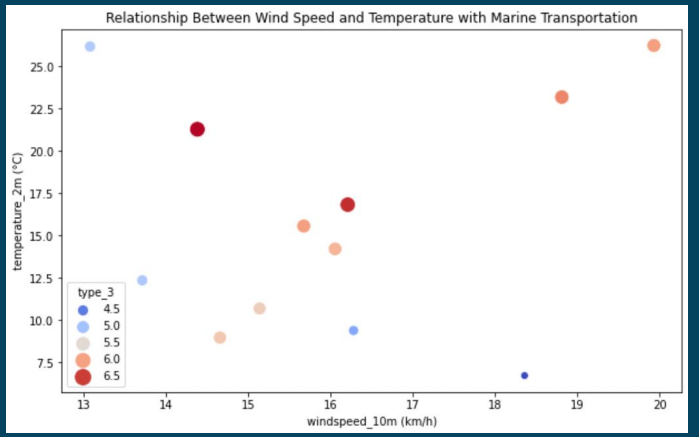
Analysis of Cross-Relationships in Weather Conditions and Transportation

(According to the Type of Public Transportation)

For public transportation modes such as Highway, Rail, and Marine Transportation, similar results are observed in the cross-analysis of Wind Speed and Temperature. However, there are diverging points for Marine Transportation. As temperature decreases, the demand for Marine Transportation decreases, and vice versa. Additionally, in low temperatures, an increase in wind speed leads to a decrease in demand, while in high temperatures, an increase in wind speed increases demand.

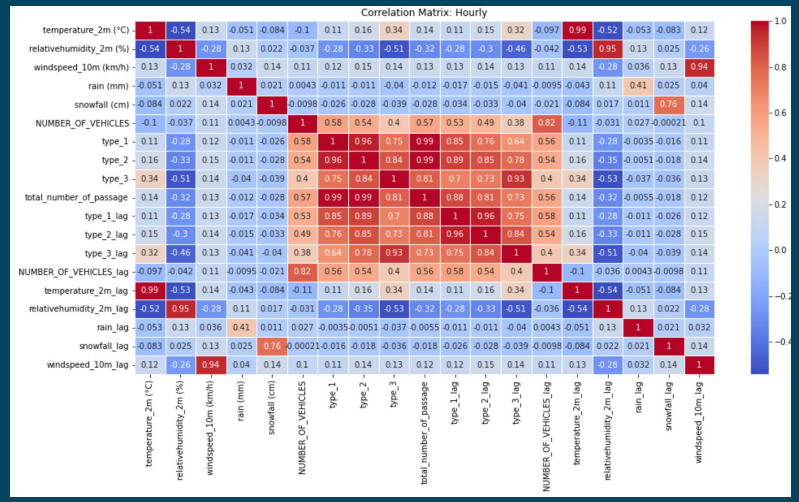


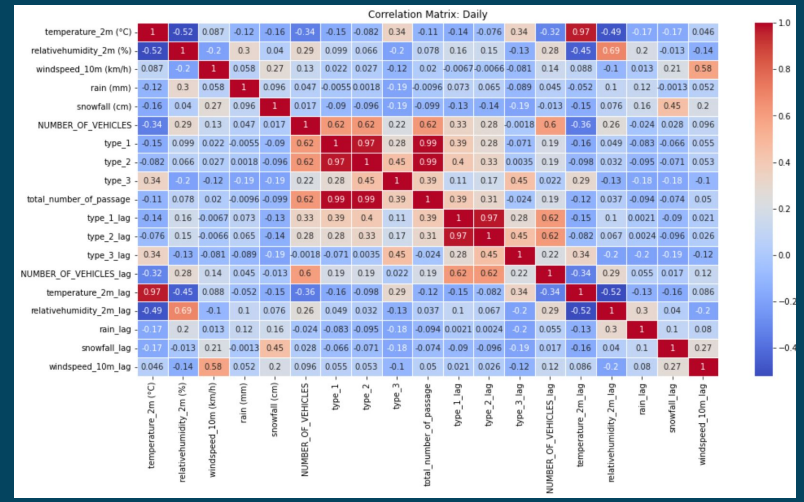




Correlation Analysis

Sea transportation is the most weather-dependent mode of transportation. Demand decreases in relatively adverse weather conditions, while it increases when the temperature rises and the weather is relatively better.
Overall, an increase in humidity and snow may lead to a decrease in demand for all types of transportation.
Finally, during rainy weather, people prefer to use their own vehicles, while they tend to use public transportation as temperatures increase.

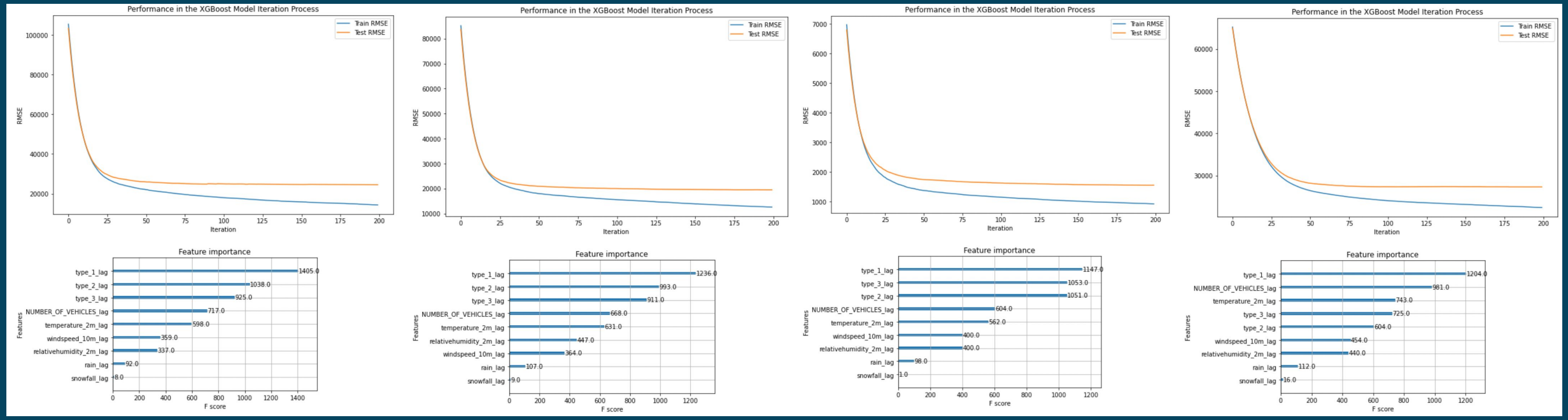




Result of the Model Trained on Hourly Data

There are two graphs for each model trained using hourly data for four different transportation types. These graphs display the performance at each iteration during model training and the importance ranking of variables used by the models in the decision-making process.

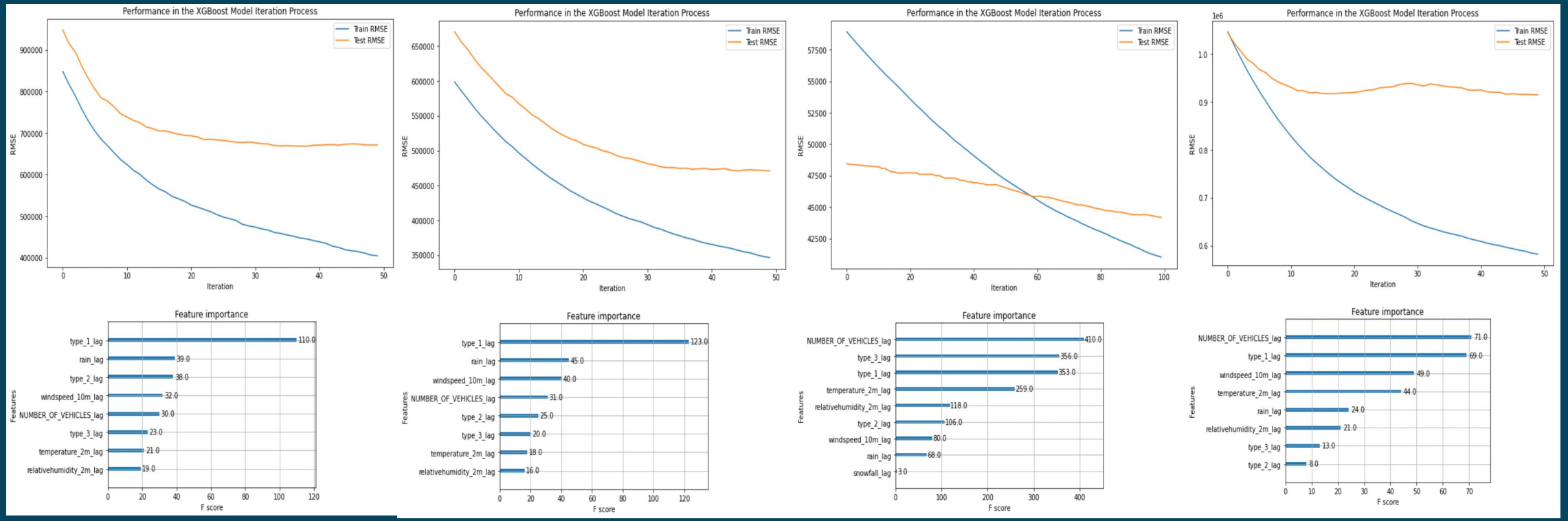
Significant improvement is observed in the first 25 iterations of the created models. An important aspect of the model results is the feature importance, as it reveals the factors influencing demand.



Result of the Model Trained on Daily Data

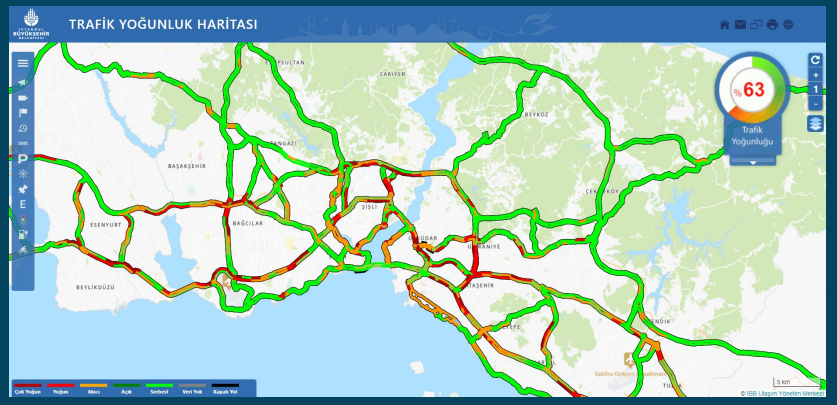
There are two graphs for each model trained using hourly data for four different transportation types. These graphs display the performance at each iteration during model training and the importance ranking of variables used by the models in the decision-making process.

The difference between test and train data is often significant for daily data. Therefore, the model built for daily data is expected to perform poorly in the test data and consequently exhibit poor performance in a live system.



Discussion

Regional Analysis



Expanded Data

Situation Analysis

Expert Opinion

Thank you for your attention.

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