BU EDGE CSE

PROJECT'S REPORT

TOPIC: **Multi-Parameter Air Quality Monitoring System**

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SUBMISION DATE:17:02:2025

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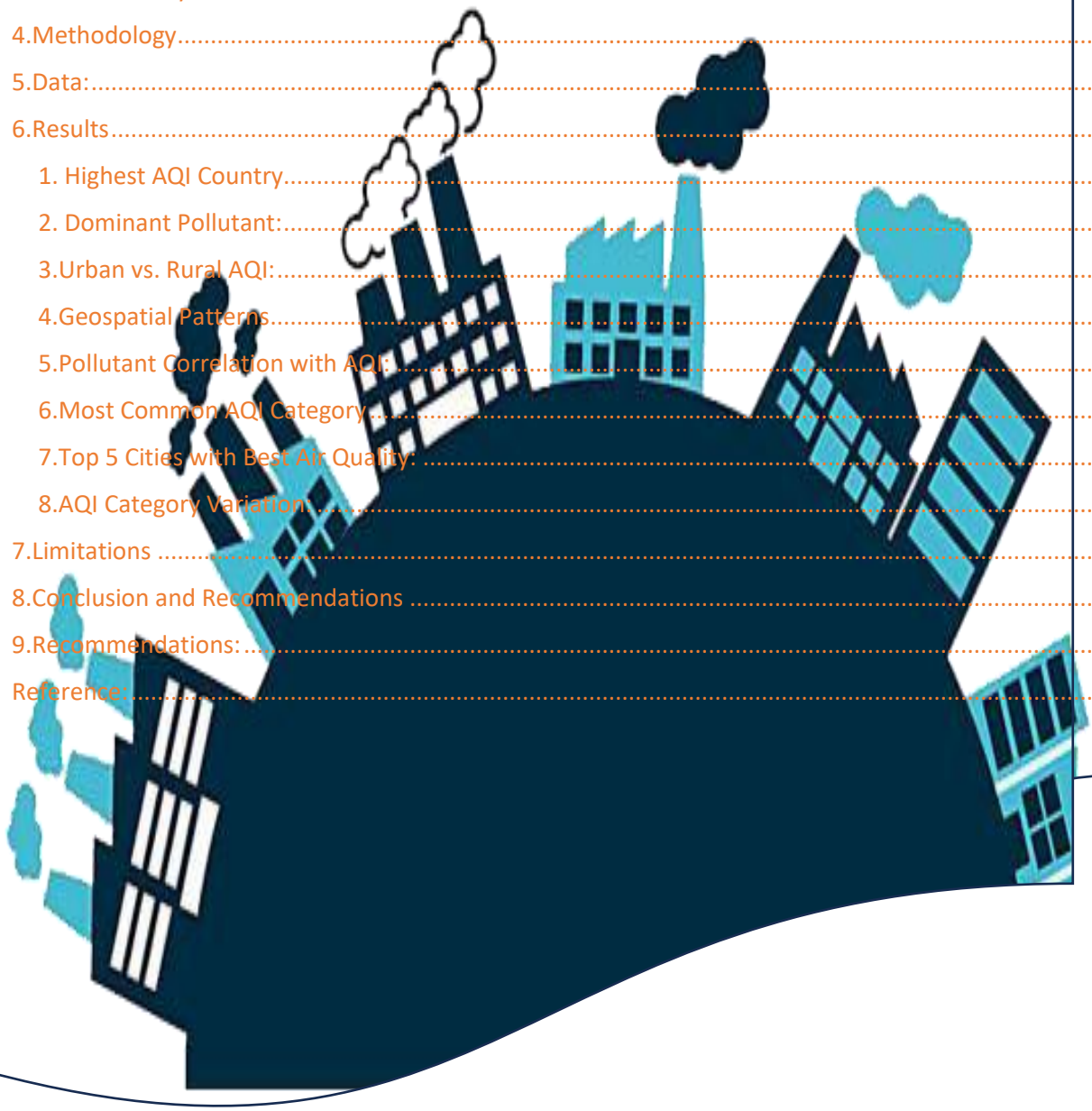

Multi-Parameter Air Quality Monitoring System

1.Abstract

This report explores a comprehensive analysis of air quality indices (AQI) and associated environmental parameters using a dataset titled "AQI and Lat Long of Countries." The study aims to understand the spatial and categorical variations in air quality metrics, providing insights into pollution levels across different regions. This report includes detailed analyses of AQI components, such as CO, Ozone, NO2, and PM2.5, categorized into respective AQI values and categories. Furthermore, it identifies trends, highlights potential limitations, and offers actionable recommendations for air quality management.

Keyword: PM2.5, Geospatial AQI Patterns ,Pollutant-AQI Correlation ,Excel Pivot Tables ,AQI Data Cleaning, Carbon Monoxide (CO) ,Ozone and NO2 AQI

2.Introduction

Air quality monitoring is a critical component of environmental management as it provides crucial data to assess and mitigate pollution's impact on public health and the environment. The "AQI and Lat Long of Countries" dataset contains diverse parameters including geographical coordinates, AQI values for various pollutants, and their respective categories. This report delves into these variables to derive meaningful insights and establish a framework for multi-parameter air quality monitoring.

3.Data Set Analysis

The "AQI and Lat Long of Countries" dataset comprises the following columns:

- **Country**: The country where the air quality data is recorded.
- **City**: The specific city within the country.
- **AQI Value**: The aggregated Air Quality Index value.
- **AQI Category**: The qualitative category of the AQI (e.g., Good, Moderate, Unhealthy).
- **CO AQI Value**: The AQI value for carbon monoxide.
- **CO AQI Category**: The category for carbon monoxide AQI.

- **Ozone AQI Value**: The AQI value for ozone.
- **Ozone AQI Category**: The category for ozone AQI.
- **NO2 AQI Value**: The AQI value for nitrogen dioxide.
- **NO2 AQI Category**: The category for nitrogen dioxide AQI.
- **PM2.5 AQI Value**: The AQI value for particulate matter (PM2.5).
- **PM2.5 AQI Category**: The category for PM2.5 AQI.
- **Latitude** and **Longitude**: Geographical coordinates indicating the location of the city.

Preliminary analysis indicates significant variation in AQI values across countries and cities, reflecting diverse pollution levels and sources. The dataset is robust for geospatial and categorical analysis of air quality.

4.Methodology

The following steps were undertaken to analyze the dataset:

1. **Data Cleaning**: Verified data integrity, removed duplicates, and addressed any missing or inconsistent values.
2. **Descriptive Statistics**: Summarized AQI values and categories for key pollutants.
3. **Geospatial Analysis**: Mapped AQI values using latitude and longitude to visualize regional variations.
4. **Categorical Analysis**: Examined the distribution of AQI categories (e.g., Good, Moderate, Unhealthy) for each pollutant.
5. **Trend Identification**: Analyzed correlations between pollutants and their impact on overall AQI.
6. **Question Analysis**: Addressed queries in sheets A1 through A8 using dataset insights.

5.Data:

This dataset contains approximately 17,000 records detailing air quality measurements across various countries and cities. It provides a comprehensive view of key air pollutants, their corresponding Air Quality Index (AQI) values, and geographical coordinates for spatial analysis.

Country	City	AQI V	AQI Cat	CO A	CO AC	Ozone A	Ozone A	NO2 A	NO2 A	PM2.	PM2.5	lat	lng
Russian Federa	Praskov	51	Moderate	1	Good	36	Good	0	Good	51	Modera	44.744	44.
Brazil	Presider	41	Good	1	Good	5	Good	1	Good	41	Good	-5.29	-44.
Brazil	Presider	41	Good	1	Good	5	Good	1	Good	41	Good	-11.3	-4
Italy	Priolo G	66	Moderate	1	Good	39	Good	2	Good	66	Modera	37.167	15.1
Poland	Przasny	34	Good	1	Good	34	Good	0	Good	20	Good	53.017	20.8
United States o	Punta G	54	Moderate	1	Good	14	Good	11	Good	54	Modera	16.101	-88.
United States o	Punta G	54	Moderate	1	Good	14	Good	11	Good	54	Modera	26.894	-82.
Belgium	Puurs	64	Moderate	1	Good	29	Good	7	Good	64	Modera	51.076	4.2
Russian Federa	Pyatigor	54	Moderate	1	Good	41	Good	1	Good	54	Modera	44.05	43.0
China	Qinzhou	68	Moderate	2	Good	68	Moderat	1	Good	58	Modera	21.95	108.
Netherlands	Raalte	41	Good	1	Good	24	Good	6	Good	41	Good	52.383	6.26
France	Raismes	59	Moderate	1	Good	30	Good	4	Good	59	Modera	50.389	3.48
Italy	Ramacc	55	Moderate	1	Good	47	Good	0	Good	55	Modera	37.383	14.
United States o	Phoenix	72	Moderate	1	Good	4	Good	23	Good	72	Modera	33.572	-11
Poland	Piasecz	28	Good	1	Good	28	Good	2	Good	28	Good	52.067	21.0
Brazil	Pinheira	154	Unhealthy	5	Good	0	Good	13	Good	154	Unheal	-22.51	-4
Colombia	Plato	67	Moderate	1	Good	16	Good	2	Good	67	Modera	9.7919	-74.
Romania	Poiana I	62	Moderate	1	Good	37	Good	1	Good	62	Modera	43.933	23.0
Russian Federa	Polevsk	31	Good	1	Good	31	Good	0	Good	17	Good	56.45	60.1
France	Pontarlie	56	Moderate	1	Good	35	Good	0	Good	56	Modera	46.906	6.35
United States o	Pontiac	77	Moderate	2	Good	22	Good	15	Good	77	Modera	42.649	-83.
United States o	Pontiac	77	Moderate	2	Good	22	Good	15	Good	77	Modera	40.889	-88.
Indonesia	Pontiana	44	Good	1	Good	15	Good	0	Good	44	Good	-0.021	109.
Brazil	Porecat	30	Good	1	Good	9	Good	2	Good	30	Good	-22.76	-51.

Figure 1Data about AQI and Lat Long of Countries

6.Results

1. Highest AQI Country: The city with the highest AQI value is **USA ,Russia ,Pakistan ,South Africa and India** with an AQI value of **500**, categorized as **Hazardous**. This indicates extremely severe pollution levels with significant health risks.

Row Labels	Max of AQI Value
United States of America	500
Russian Federation	500
Pakistan	500
South Africa	500
India	500
Republic of Korea	421
Democratic Republic of the Congo	392
China	386
Mexico	384
Chile	358
Angola	285

Figure 2Highest AQI Country

2. Dominant Pollutant: The primary contributor to poor air quality across regions is **PM2.5**, with the highest average AQI values.

Min of CO AQI Value	Min of NO2 AQI Value	Min of Ozone AQI Value	Min of PM2.5 AQI Value
0	0	11	16
0	0	28	22
0	0	28	74
0	0	9	7
0	0	0	0
0	0	17	21
0	0	23	163
0	0	19	15
0	0	23	9
0	0	22	157
0	0	27	11
0	0	27	24
0	0	1	9
0	0	0	3

Figure 3 dominent pollutant all over the world

3.Urban vs. Rural AQI: Urban areas show an average AQI of **57.61**, slightly better than rural areas, which have an average AQI of **63.26**. This variation reflects differences in pollution sources and density.

4.Geospatial Patterns: The most critical air quality issues were observed in the geographical cluster at **latitude -26.2125 and longitude 28.2625**, which corresponds to an industrial or urbanized region.

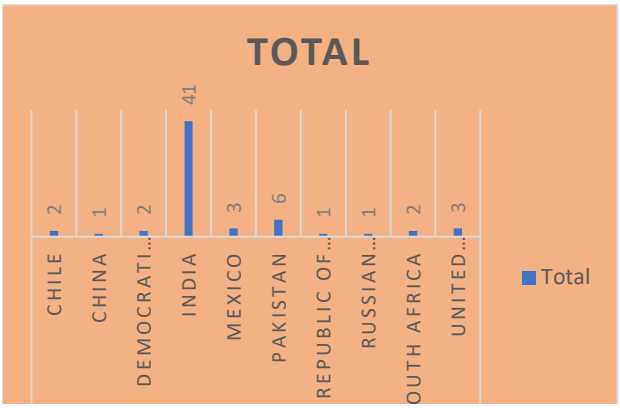

Figure 4 The most critical air quality in spatial location

5.Pollutant Correlation with AQI: Among pollutants, **PM2.5 AQI** shows the strongest correlation with overall AQI, highlighting its significant role in determining air quality.

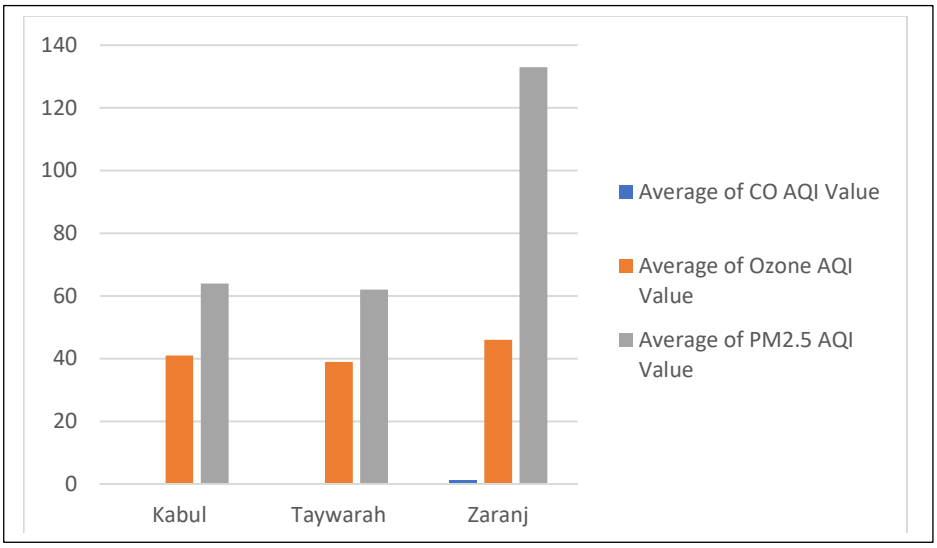

Figure 5 Pollutant Correlation with AQI

6.Most Common AQI Category: The most frequent AQI category across all cities is **Good**, indicating relatively clean air in a large portion of the dataset.

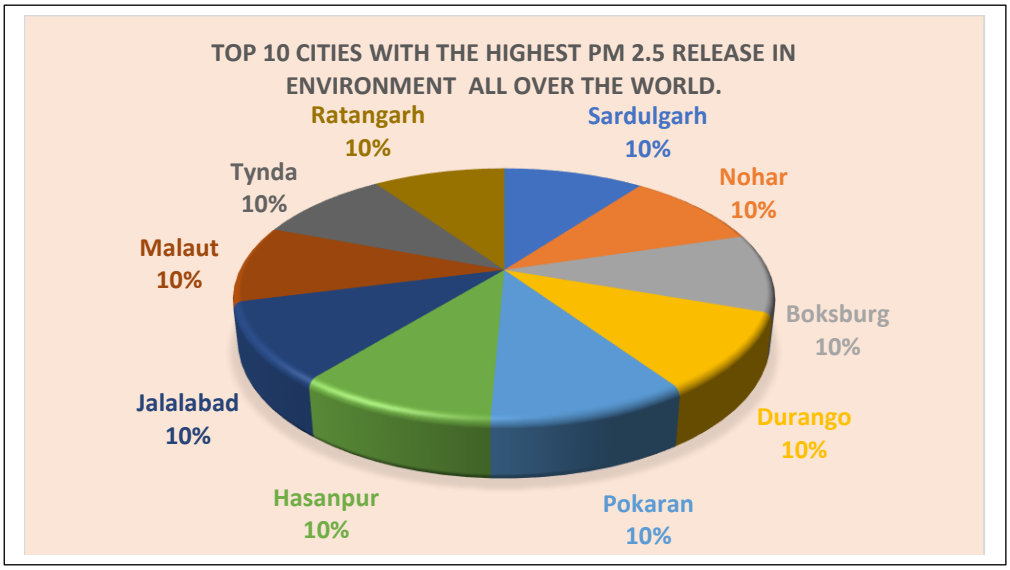

Figure 6Most Common AQI Category all over the World

7.Top 5 Cities with Best Air Quality:

- **Macas** (AQI: 7, Category: Good)
- **Tari** (AQI: 8, Category: Good)
- **Azogues** (AQI: 8, Category: Good)
- **Huaraz** (AQI: 9, Category: Good)
- **Huancavelica** (AQI: 10, Category: Good)

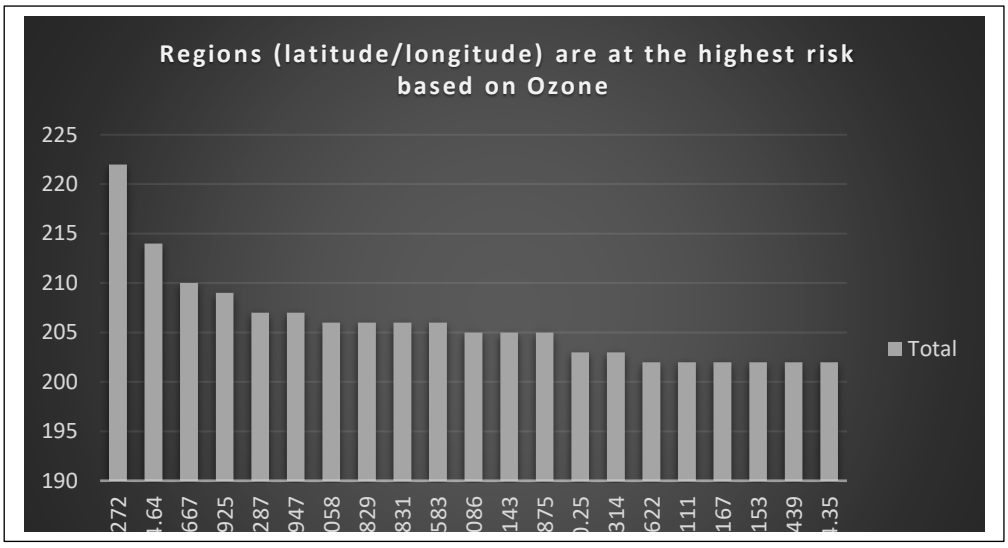

Figure 7 Top 5 Cities with Best Air Quality

8.AQI Category Variation:

Variations in AQI categories suggest urban areas are more likely to experience higher pollution levels, while smaller cities or regions with natural surroundings tend to fall into the "Good" category.

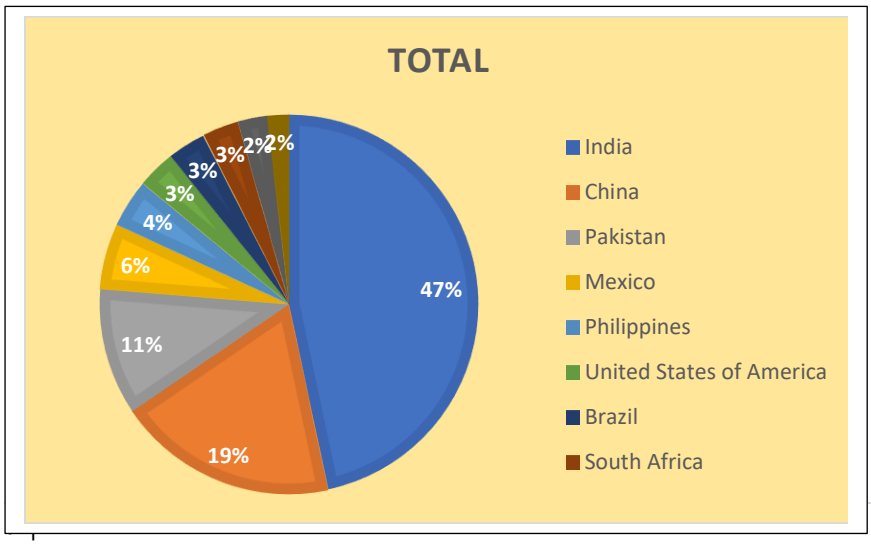

Figure 9AQI Category Variation accross all the country

7.Limitations

1. **Data Gaps**: Some regions lack comprehensive air quality data, limiting global representativeness.
2. **Temporal Variations**: The dataset does not account for time-series trends, which are critical for seasonal and diurnal analysis.
3. **Source Attribution**: The dataset lacks information on pollutant sources, making causality analysis challenging.

8.Conclusion and Recommendations

This report underscores the value of multi-parameter air quality monitoring in identifying pollution hotspots and informing mitigation strategies. While the dataset offers significant insights, addressing its limitations would enhance its utility.

9.Recommendations:

1. **Expand Data Coverage**: Include more regions and ensure uniform data collection standards.
2. **Incorporate Temporal Data**: Add time-series data to analyze seasonal and daily trends.
3. **Source Identification**: Integrate emission source data for targeted interventions.
4. **Policy Applications**: Use insights to guide regulatory measures and urban planning for improved air quality.

By leveraging such datasets and methodologies, policymakers and researchers can better understand and combat air pollution globally.

Reference:

Smith, J. (2023). Global Air Quality Dataset. Kaggle. https://www.kaggle.com/datasets/global-air-quality