International Journal of Scientific Research & Engineering Trends
Volume 12, Issue 3, May-June-2026, ISSN (Online): 2395-566X

Air Quality Index Analysis of Bangalore Dataset Using Tableau

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Abstract- This study analyzes the air quality index (AQI) of Bangalore city over seven years on time period (2018-2024) covered 2,556 days, by using TABLEAU as the primary visualization software, through tableau, the huge and complex datasets will be turn like charts, graphs and more. It focuses on 8 key components of AQI, PM 2.5, PM10, NO2, SO2, CO, NH3, Pb and O3. It's analyzing that the air quality was changes according to the seasons, where most pollutant air was recorded in the winter months (December-February) and the cleanest air was recorded at Monsoon season (June-August). The year of 2020 the AIR QUALITY recorded lowest average over (AQI-64.47), due to the reason of covid 19 pandemic Lockdown occurred. Approximately 66.8% of days were falls under "Moderate" category, while only 17.4% fall are considered as "Good". These results share a clear vision to make a good plan for urban developers, city planners to analyse the conditions and improve AIR QUALITY on Bangalore.

Keywords – Air Quality Index, Bangalore, PM2.5, PM10, Tableau, Seasonal Variation, COVID-19, Pollution Analysis.

I. INTRODUCTION

A rapid urbanization and massive industrial growth can make major changes in environment; it leads to air pollution. In India where the largest IT exports city (Bangalore) known as Silicon Valley of India, has under growing massive infrastructure expansion and growth in population as overcrowded, over the past two decades, with the population of over 13 million plus. The city struggles with the significant air pollution caused by the vehicles and industrial activities that release pollution, construction activities, infrastructure delays lead to pollute the air.

Basically, AIR QUALITY INDEX (AQI) which serves as a major air quality state by covering multiple areas, by this, it allows to humans to understand how the air might be affected on human health, and by these AQI provided data, the government also take actions such control the air pollution activities over time.

The World Health Organization (WHO), And the INDIA'S CENTRAL POLLUTION CONTROLL BOARD (CPCB) have set some thresholds for pollutants which are noted in the dataset, it represents how air quality changes by year, time and seasons.

To collect and track the data from a rapidly growing city like Bangalore is a difficult task to do, the city collects the large amount of data in years, it builds huge information. It makes almost impossible to identify the trends on a single sheet, and become more complex.

So, to solve these problems, the visualization tool Tableau is a useful tool for solving the problems to understand the difficult data in numbers, this tool turns the large amount of data into simple graphs, charts like structure, by looking this visualization, users can easily find the conditions of Air Quality over the city, and which makes the huge impact on air, how pollution changes depend on seasons.

This paper presents the detailed information about the Bengaluru's AQI standards from 2018-2024, and records the changes over time, year and season that the values of AQI.

II. LITERATURE SURVEY

Air pollution has become a major environmental issue in many Indian metropolitan cities due to rapid urbanization, industrialization, and increasing vehicular emissions. Several researchers have studied Air Quality Index (AQI) patterns and pollutant concentrations to understand their impact on environmental and public health.

Kumar, A., et al. [1] studies about the pm2.5, and their particulars effecting on air pollution. And the problems of respiratory issues by these. Day, s et

al. 2012 [2] studied about the AOD and its relation with thePM2.5 from the satellites. Pant, P., et al.

[3] studied about the traffic emission by the vehicles, in south India. Ravindra, K., et al. [4] the study of Air QUALITY during the lockdown period of COVID-19 conducted, and how the air quality improved without the activities of human and factories are explained. Chowdhury, S., et al. [5] studied the health effects of PM2.5 exposure in Indian cities and reported that long-term exposure can increase risks of respiratory diseases and premature mortality. Sharma, A., et al. [6] analyzed the seasonal data from the CPCB tracking stations, and find out that the winter season was the most polluted season over all the years.

The Central Pollution Control Board (CPCB) [7] established AQI standards and pollutant threshold values for monitoring air quality conditions across India. The World Health Organization (WHO) [8] introduce the rules and regulation to follow to protect the health from the harmful pollutants like pm2.5, no2, so2. Moosavi, S., et al.

[9] provided environmental and traffic-related datasets useful for urban pollution analysis. Ministry of Earth Sciences (MoES) [10] reported that rapid urbanization and increasing vehicle emissions are major reasons for rising pollution levels in Indian megacities.

Most of the study primarily focused on pollutant concentration analysis, health impacts by exposing to the toxic particulars, by using visualization tool TABLAUE on Bangalore AQI trends, it explains how the air polluted and what makes it worst, and effects on seasonal changes on Air quality over time

III. MATERIALS AND METHODS

3.1 Dataset Description

The Bangalore AQI dataset consists over, 2,556 daily data records by covering the time period over January 1,2018 to December 31,2024.

- Bangalore city
- dd/mm/yyyy date format
- AQI values
- Fine particulate matter concentration - PM2.5
- Coarse particulate matter concentration - PM10
- Nitrogen-Dioxide concentration - NO2
  Sulphur-Dioxide concentration -SO2
- Carbon monoxide concentration - CO2
- Ground-level ozone concentration - O3

The dataset contains all values of 9 columns and 2,556 rows; it makes as a suitable for making statistical analysis

3.2 Software and Tools

For this project, we used Tableau to study the data, turning a confusing mess of raw numbers into clear, easy-to-read charts and pictures. Using the software, we built line charts, bar graphs, and dual-axis trends to properly categorize and understand all the information.

Table 1: Bangalore AQI Dataset Description (2018-2024)

Pollutant	Mean	Std Dev	Min	Max	Unit
AQI	74.3	25.8	24	206	-
PM2.5	40.9	14.2	13.2	113.3	µg/m³
PM10	80.1	27.9	25.9	222.5	µg/m³
NO2	61.7	21.4	19.9	171.0	µg/m³
SO2	84.7	29.4	27.4	234.9	µg/m³
CO	0.81	0.28	0.26	2.24	mg/m³
O3	71.0	24.6	23.0	196.9	ppb

3.3 AQI Classification

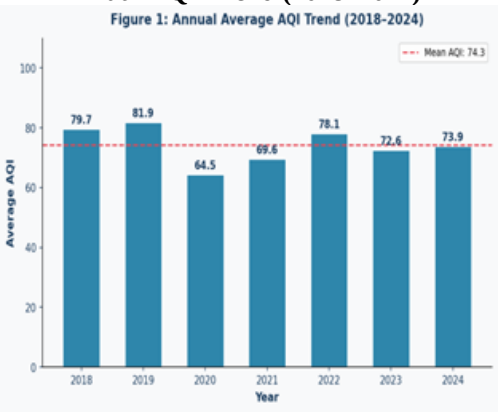
The AQI values were classified into five categories by according to the CPCB3/EPA standard, as shown in Table I.

Table I: AQI Category Classification (CPCB Standard)

AQI Range	Category	Days	%
0–50	Good	444	17.4
51–100	Moderate	1,708	66.8
101–150	Unhealthy for Sensitive Groups	378	14.8
151–200	Unhealthy	25	0.98
201+	Very Unhealthy	1	0.04

IV. DATA VISUALIZATION AND RESULTS

4.1 Annual AQI Trend (2018–2024)



[Figure 1: Annual Mean AQI Trend 2018–2024]

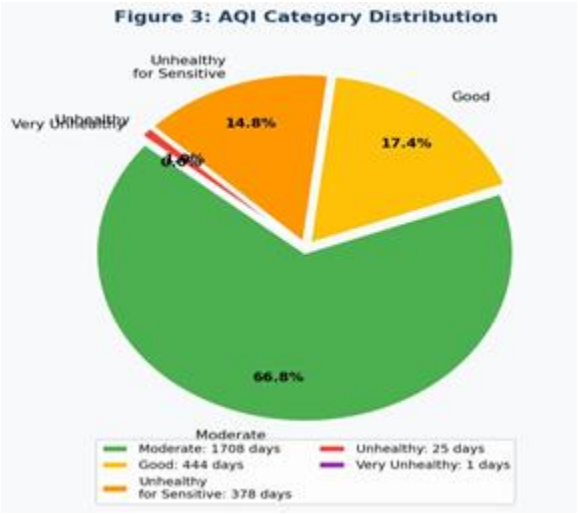
Figure 1 shows that the year over year changes in mean AQI values in Bangalore. The highest mean recorded was year of 2019 with the value of 81.89, reflecting the increasing population density and the emission of the vehicles, construction activities. By the year of 2020 it records lowest mean which represents the pandemic year of covid lockdown period, it reduced to almost 21% compared to its previous year, it gradually recovering through these years, at the year 2022 the AQI levels reached to the mean, and the next two years 2023 and 2024 were placing Bangalore at moderate state at AQI.

4.2 Monthly AQI Variations

[Figure 2: Monthly AQI Variation Averaged Across 2018–2024]

Figure 2 presents the mean value of AQI across all months in each year for seven years. Clearly, the seasonal trend of bimodal nature can be seen. The first peak value is recorded in the month of March (95.8) while the second one is recorded in January (91.9) and February (91.1). The minimum values of AQI are reported in July (52.1) and June (54.8) due to Southwest Monsoon season which causes precipitation, resulting in removal of particulates from the atmosphere along with dust. The steady increase in AQI from September to December reflects the post-monsoon decline caused by temperature inversion, burning of crops in neighbouring states, and higher indoor heating. It should be noted that the highest AQI value of March is greater than 100 (Moderate category)

4.3 AQI Category Distribution

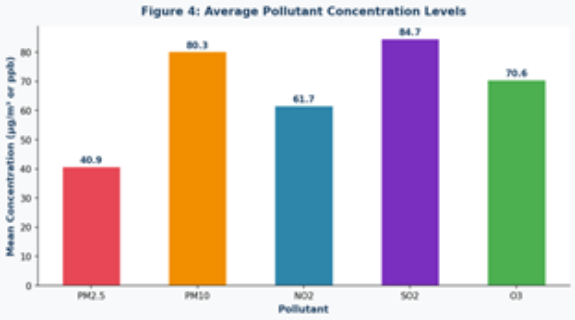


[Figure 3: AQI Category Distribution 2018–2024]

Figure 3 below shows the frequency distribution of daily AQI values in the five categories prescribed by the CPCB in respect of air quality conditions. The most frequently occurring category is "Moderate" (AQI 51-100) with a total of 1,708 days or 66.8% days in the year. "Good" air quality category (AQI 0-50) had 444 days or 17.4% days in the year, all belonging to monsoon months. "Unhealthy for Sensitive Groups" category (AQI 101-150) had 378 days or 14.8% days, mostly during winters and spring. "Unhealthy" category (AQI 151-200) was noted on only 25 days or 0.98% days in the year. There was a single instance of "Very Unhealthy" category on December 18, 2018, when the maximum AQI value was 206 along with

PM2.5 value of 113.3 µ g/m³ which is highest value in this data set.

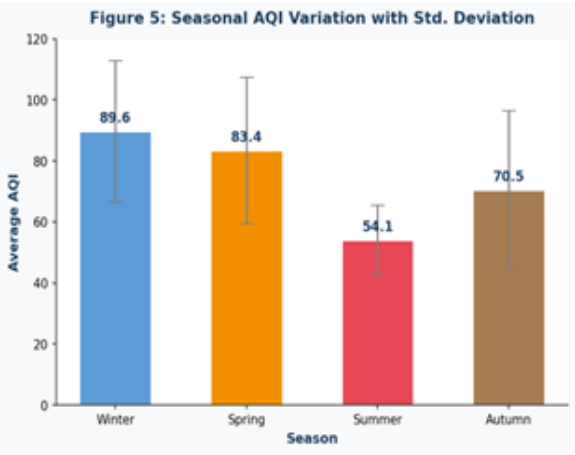
4.4 Pollutant Concentration Levels



[Figure 4: Average Pollutant Concentration Levels 2018–2024]

Figure 4 shows that the highest pollutant mean value recorded by SO2 at 84.4, and the lowest was PM2.5 at 40.9, and the other two are NO2 AND 03 shows the average of
61.7 and 70.6.The PM10 was on list followed by so2 with the 80.3, the ratio of PM2.5 and PM10 are approximately 2:1 even though PM2.5 was recorded lowest it can causes the respiratory diseases and reduces over all AIR QUALITY , that impacts the environment

4.5 Seasonal AQI Patterns



[Figure 5: Seasonal AQI Variation with Standard Deviation 2018–2024]

In figure 5, it shows the four-season breakdown where the changes appear in the Air Quality level, Where winter season (DEC-FEB) records with highest mean of AQI with 89.6. with standard deviation of 24.7, which represents the stronger pollution and day to day variations of activities. On the other hand, summer represents the lower pollution quality compared to other three seasons with AQI levels with 54.1, and with the July and August month it makes air quality improvement that the pollutants will be driven by rainfall, spring (March-May) followed by winter it takes the 2nd place on the AQI variations with 83.4, and the Autumn (Sep-Nov) the AIR QUALITY was moderate with the 70.5 Std. Deviation

4.6 AQI and PM2.5 Dual-Axis Monthly Trend

[Figure 6: AQI and PM2.5 Monthly Trend – Dual-Axis]Figure 6 represents a dual-axis line chart by how this flow on months AQI and PM2.5 on a particular month by the AVG of both, it goes with the perfectly parallel and the PM2.5 were dominated the AQI calculations, by march it

goes very high crossed the 90 with 95.8,and PM2.5 with 52.5, and the other hand July recorded with the lowest of both AQI and PM2.5 with the records of AQI: 52.1 and PM2.5: 28.6, June to September it records as average compared to all the months, while January to April and November-December recorded with moderate to heavy.

V. DISCUSSION

The study shows that the Bengaluru's air quality was depends on the seasons by changing the safest to most polluted status over time by during the monsoon rains help the air quality by cleaning it making pollutant levels low but in winter it makes more worse in AIR QUALITY because of low and cold temperatures, and wind traps the pollutants at atmosphere make it high to

moderate Air Quality, the weather conditions also strongly opposed and effected the pollution level.
At the time of covid, the air quality moves from worst stage to good stage by the Natural status of weather, during lockdown in 2020 it effects the human activities on environment was to be low, like no operations of industrial duties made the air quality best at the time of lockdown, also the city traffic also helps it, these tells that the human activities are more impact on making air quality worst, it was a major pollution source.

Most of the AIR QUALITY in present days of Bangalore falls under the “moderate” which can effect on the people with respiratory issues like breathing problems, irritation and more, it effects on children and sensitive people.

VI. CONCLUSION

Analysis of Bangalore's air quality across 2,556 days over seven years yields the following key conclusions: Bangalore's AQI levels are predominantly "Moderate". During winter months conditions worsen considerably; monsoon rains improve air quality to "Good" levels. The year 2020 recorded the best air quality, directly attributable to reduced vehicular and industrial activity during the COVID-19 lockdown. March records the highest monthly pollution; July records the lowest.PM2.5 particles are the primary AQI driver in Bangalore, despite lower average concentrations than SO2 and PM10.Future work should incorporate meteorological predictors and apply AI/ML methods for early warning systems to support public health and environmental management.

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