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Experimental Analysis on Continuous Ambient Air Quality Monitoring System (CAAQMS) at Vandalur, Chennai, India

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ABSTRACT

In the present pandemic scenario in the world due to Corona virus, the quality of air is one of the most influencing factors for all our livelihoods. We present the brief details with limited data of continuous monitoring system of air quality for few months during the period Feb 2023 to April 2023. The continuous air quality monitoring station at our Institute is implemented by Tamil Nadu Pollution Control Board (TNPCB), Government of Tamil Nadu in the year 2021. It indicates that the Air Quality Index is 13% that can be considered as very good and provides minimal impact on 87% of the air. The Air Pollutant Standard Index includes PM_{10} and $PM_{2.5}$ parameters. The other monitoring parameters are O_3, NOx, SO_2, CO, NH_3, WS (m/s), Solar Radiation (w/m²), WD (°), RH (%), BP (mbar) and Rain (mm). The results of one-day data analysis have shown more than one Eigen value and no negative Eigen values. Air Quality and Health issues through Factor analysis. Data need to be efficiently integrated from all the other stations and transfer to a center with real-time information using sensors. 3D graphs for 12 different parameters considering 3 months' data are presented for better visualization and comparison.

Key words *: Air Quality Index, Monitoring Station, Wind Speed and Direction, Air Pollution, Impact, Environment and Livelihoods.*

Introduction

The world health organization (WHO) reports in 2012 that about 7 million people die per year from toxic air exposure. In 2016, ambient air pollution alone causes some 4.2 million deaths, while household air pollution caused an estimated 3.8 million deaths in the same period due to cooking with polluting fuels and technologies. Experts are now wondering whether the ad hoc prevention and control systems established in lace to curb air and water pollution that the state has implemented is to be blamed or not. Accordingly, one should estimate the air quality with standard instrumentation. The instruments for both air quality assessments and monitoring are calibrated primarily to European standards and are adapted to south Indian climatic conditions (Naveen and Anu, 2017; Nelson, 2012).

The capital of the Indian state of Tamil Nadu is Chennai, originally called Madras (the name used

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officially till 1996) situated along the Coromandel Coast of the Bay of Bengal. One of south India's most important centres for culture, commerce, and education. The fourth-most populous urban agglomeration in India and sixth-most populous city, respectively, are both according to the 2011 Indian census. Given that Chennai maintains its enduring customs and rich history, it is not surprising to refer to it as an exotic state (Tidblad *et al.,* 2009). I n view its importance, air quality monitoring is one of the essential requirements for the health of the people living in Chennai (Gamelin *et al.,* 2009; Guttikonda *et al.,* 2015; Haas *et al.,* 2015; Dutta *et al.,* 2021)

One of the greatest municipal economies in India is found in the Chennai Metropolitan Area. Given that Chennai is home to more than one-third of India's automobile sector, the city is known as "The Detroit of India." At 35,000 in 2009, 82,790 in 2011, and a projected above 100,000 by 2016, Chennai has India's third-largest foreign-born population. The cultural centre of South India, Chennai, is well renowned. Three months of hot summer weather are experienced in Chennai (March to May). 35 °C at night and 40 °C during the daytime are the maximum temperatures. We can have significant rainfall and high wind speeds during the monsoon season (June to August). The temperature in Chennai during the winter season (December to February) is very mild, ranging from 20 °C to 25 °C. In view of such diversifying variation of seasonal variation, it is interesting to study the air quality in order to take necessary steps for mitigation, if so required.

The method of monitoring ambient air quality is normally done with automated through continuous operation of the equipment. Two types of automatic equipment are available for air quality monitoring, namely, the fixed and mobile stations. In India, the Central Pollution Control Board (CPCB), State Pollution Control Board (SPCB) and the Regional Directorate of CPCB (RDs) are responsible for carrying out regular environment air quality monitoring at least at two or three locations in states. In Tamil Nadu state, the air quality monitoring stations are operated both in urban and also a few nearby rural areas. For example, the continuous air quality monitoring stations are located at Thoothukudi, Coimbatore, Salem, Madurai, Trichy, Cuddalore and Mettur and also at a few other places in Tamil Nadu (Nadeem *et al.,* 2020). Additionally, a few more stations have been installed to understand the quantity of the pollutants at different locations by government of Tamil Nadu under continuous air quality monitoring station (CAAQMS) scheme. As an example, the CAAQMS air quality data as observed at 28 stations for one day (01-04-2023) are provided below in Table 1.

As can be seen, 23 stations out of 28 stations have exhibited the air quality as satisfactory or good. Only five stations – Coimbatore, Hosur, Tiruppur, Thoothukudi and Vellore- have shown the air quality index values has just crossed 100 mark and can be considered as 'moderate' Table 1. (Source: TNPCB, Govt. of Tamil Nadu, 2023; https://tnpcb.gov.in/)

Air Effluence

It is common knowledge that there are various forms of air pollutants, including gases, particles, and biological molecules. Air pollution is the accumulation of contaminates in the environment from various sources including from agriculture (Sthapit *et al.,* 2013) that are harmful to the health of humans

Table 1. Air Quality Index
(Air Quality Index of CAAQMS on April 01, 2023)

S. No	Location	Air Quality	Index Value	Prominent Pollutant
1	Ariyalur	Satisfactory	62	NO_2
2	Chengalpattu	Satisfactory	72	PM_{10}
3	Chennai	Satisfactory	65	NO2 , O3
4	Coimbatore	Moderate	101	CO
5	Cuddalore	Good	29	$PM_{2.5}$
6	Cuddalore SIPCOT	Satisfactory	100	PM_{10}
7	Dindigul	Satisfactory	73	PM_{10}
8	Gummidipoondi	Satisfactory	87	PM_{10}
9	Hosur	Moderate	121	CO
10	Kanchipuram	Good	44	PM_{10}
11	Karur	Satisfactory	75	PM_{10}
12	Kathivakkam	Satisfactory	99	PM_{10}
13	Nagapattinam	Good	63	PM_{10}
14	Namakkal	Satisfactory	36	O3
15	Ooty	Satisfactory	96	PM_{10}
16	Pudukkottai	Good	49	PM_{10}
17	Ramanathapuram	Good	50	PM_{10}
18	Raniper, SIPCOT	Satisfactory	99	PM_{10}
19	Salem	Satisfactory	83	SO_2
20	Thoothukudi	Moderate	102	PM_{10}
21	Tirupur	Moderate	152	PM_{10}
22	Tirunelveli	Satisfactory	68	PM_{10}
23	Thanjavur	Satisfactory	52	O3
24	Trichy (City)	Satisfactory	58	O3
25	Trichy (Rural)	Satisfactory	52	PM_{10}
26	Vandalur	Satisfactory	54	PM_{10}
27	Vellore	Moderate	114	PM_{10}
28	Virudhunagar	Satisfactory	83	PM_{10}

and other living organisms and also harmful to the materials. Normally the air quality is calculated on the basis of the concentration of parameters of air pollution determined above or below the normal value of ambient air quality. This means the air quality norm is calculated based on the maximum amount of air pollution components that can be tolerated in the atmospheric air. In order to avoid air pollution, the national standard for ambient air quality is set as the maximum tolerant level for ambient air quality (Kurniawan, 2018).

In addition to having a negative impact on global warming, local factors that affect the ecology, such as acid rain, respiratory and malignant diseases, plant ageing, building damage, etc., can also be negatively impacted by air pollution. Air effluence is dominated by road traffic in large cities, especially in the main highways. But effluence levels are variable because it depends on environmentally friendly or atmospheric variables and also it depends on traffic patterns, size, and orientation of the buildings or land use (Abernethy, *et al.*, 2013).

Metropolitan air effluence is a major conservational issue. The possibility of a heart stroke, heart disease, acute respiratory disorders like asthma and cancer is rising as urban air quality is declining. It also leads to damage to construction materials and cultural subsistence (Tidblad *et al.*, 2009). Many studies have been done on the negative impacts of air pollution and its sources (Adam, *et al.*, 2014 and Ukaogo, *et al.*, 2020). The decrease in urban air quality is observed to be primarily due to the rise in traffic emissions. The key component of air pollution is transport-related emissions (Maynard, 2009).

Nitrogen oxides, carbon monoxide, and volatile organic compounds are among the many air pollutants that are released by vehicles with petrol-derivative engines, making them the most problematic (VOCs). The particulate matter has a major effect on urban air quality (Batterman and Hatzivasilis, 2007; Wu *et al.*, 2011). In this context, one need to understand the issues related to the Ambient Air Quality.

Ambient Air Quality Standard

Ambient air quality refers to the condition of quality of air surrounding us in the outdoors. In India, the National Ambient Air Quality Standards are the standards set by the Central Pollution Control Board (http://cpcb.nic.in/) and is applicable nationwide. The CPCB has been assigned this task by the Air (Prevention and Control of Pollution) Act, during 1981. As per this act three areas have been identified (i) Industrial Area (ii) Residential (iii) Rural Areas.

Programs to minimize household use of biomass cooking fuels have been introduced by the Government. But their motivation does not involve reductions in environmental emissions. If all households moved to renewable fuels, the reduction in environmental pollution could avoid about 13 percent of premature mortality in India. Additionally, the country's average atmospheric $PM_{2.5}$ concentrations will be planned to meet the national standards.

In view of the above background scenario of air quality issues in India, Chowdhury *et al.*, (2019), have analyzed various pollution sources in a systematic way through air monitoring system (CAAQMS) at Vandalur, Chennai by comparing with other locations quality of air. Air quality data used in this study are collected as a part of network of stations being operated under the aegis of Tamil Nadu Pollution Control Board (TNPCB). Initially, pollutant concentrations are measured using Factor analysis on Ozone (O_3), Nitrogen Oxides (NOx), Sulfur Dioxide (SO_2), particulate Matter (PM_{10}) and ($PM_{2.5}$), Carbon Monoxide (CO) and Gaseous Ammonia (NH_3). The results are discussed based on the monitoring station value as compared to the national ambient air quality standards, air pollutant index, air quality index etc. parameters.

Data Analysis and Interpretation

Fig. 1 shows the location of the Air Quality Monitoring Station established under MOU between Tamil Nadu State Pollution Control Board and B.S. Abdur Rahman Crescent Institute of Science and Technology campus, Vandalur, Chennai, Tamil Nadu. It is located adjacent to the Vandalur Zoo surrounded by vegetation and trees near the junction of GST-Kolapakkam Road junction.

The network of roads on GST Road leads to major educational institutions such as SRM Institute of Science and Technology, on GST Road, Tagore Medical College, Vellore Institute of Technology etc. in Kolapakkam Road. Due to various educational institutions, there is a large movement of college vehicles transporting students from different places to the colleges. Additionally, there is a direct road to a major city – Bangalore from here. Apart from this, there are a few flyovers just completed for ease of traffic and it leads to additional vehicular traffic near the pollution. measurement sensor location. In view of all these it has become essential to establish

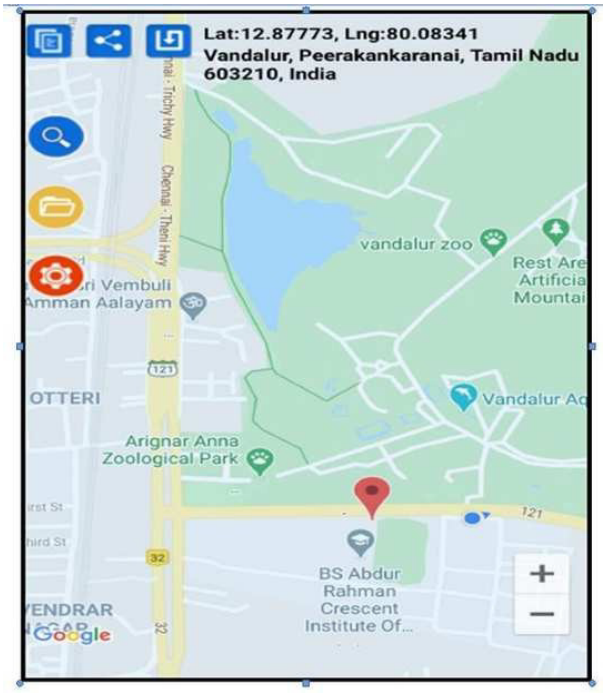

Fig. 1. Location map of the Air quality monitoring station, Vandalur, Chennai, Tamil Nadu

the monitoring station near the junction.

Apart from this station, various other Ambient Air Quality Monitoring stations (AAQMS) established by TNPCB around Chennai are Kathivakkam, Manali, Thiruvottiyur, Kilpauk, Thiyagaraya Nagar, Nungambakkam, Anna Nagar and Adyar. As an example, in Figure 2 the details of wind speed (m/s) or 30 days duration at Vandalur for the period from 29-10-2022 to 27-11-2022 is presented. It can be seen that majority of days; the wind speed is less than 1 m/s and for few days during 24th to 27th November 2022 it has shown more than 1 m/s reaching to a maximum of 3.65m/s on 24th November 2022.

The below chart shows the details of Wind Direction (°) for the same period of 30 Days with a minimum of 110(°) to the maximum of 210.28 (°) This means the wind direction is dominantly towards ESE to SSW direction (Fig. 3). As the location is close to the coast and geographically placed in South India, this is the expected direction in this season of the year. Both wind speed and wind direction are the two important parameters on the air quality measuring parameters as the pollutants may be blown away from the sensors by the wind.

The below chart (Fig. 4) shows the details of Relative Humidity (%) for the same period of 30 Days with the minimum 74.62 (%) up to the maximum of 90.41 (%) It is well known that relative humidity

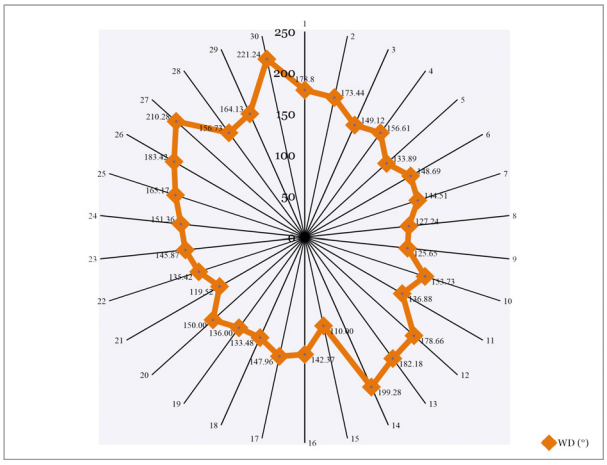

Fig. 3. Average Value of Wind Direction (°) of 30 Days

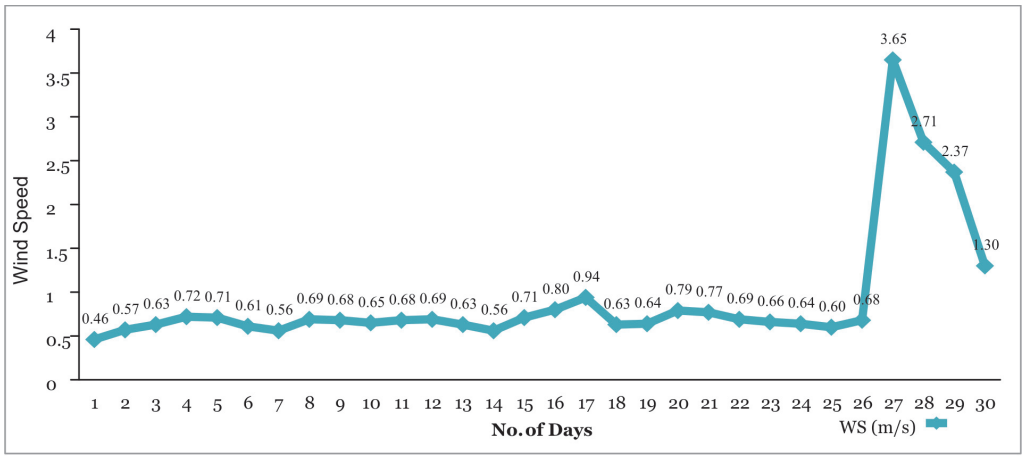

Fig. 2. Average Value of Wind Speed Accuracy of 30 Days

represents the water vapor content in the atmosphere expressed in terms of percentage of the amount that the atmosphere can retain. This is otherwise known as moisture holding capacity of the atmosphere. We all know that with 100% humidity in the atmosphere human beings cannot sweat to remove body heat to the atmosphere. As the relative humidity increases, human beings feel more heat than the real temperature in the atmosphere. Similarly, as the relative humidity very low, human beings feel less temperature than the real atmospheric temperature. Here at Chennai, the relative humidity is nearly 75-80%, persons staying here feel more heat than the atmospheric heat. By comparison one can see that relative humidity is very high during the last week of November. It correlates well with high wind speed which in turn affects the Air Quality index parameters.

Air Quality Index: Air quality index depends on the measurement of particulate matter and other gases such as Ozone, Nitrogen Dioxide, Sulfur Dioxide and Carbon Monoxide (Kurniawan, 2018). The parameters in any air quality measuring station does for every one hour or compute the average value for every one hour. The values vary 0-500; lower the value means better atmosphere and higher values of AQI means health hazards. Usually less than 100 is considered as satisfactory and less than 50 is considered as good quality. Up to 200 called as moderate and more than 200 is considered as bad quality of air in the region.

The below table and chart show the details of Air Quality Index for the same period of 30 Days. From the above table and chart (Fig. 5) it is clear that air quality is satisfactory and good during most part of the month (>50%). The balance number of days (13), the air quality is considered as moderate and there is no severe condition on any day during the month. All the above sample data indicates that the area in and around Vandalur air quality is good to very good in nature. Before we proceed with the other parameters, it is necessary to test the quality of the data. In order to test the quality of the data variables and their relationship, factor analysis is the best option.

Table 2. Descriptive Analysis

S.No	Air Quality Index (AQI)	No. of Days	Percentage
1	Moderate (101–200)	13	44
2	Satisfactory (51–100)	13	43
3	Good (0–50)	4	13
	Total	30 Days	100%

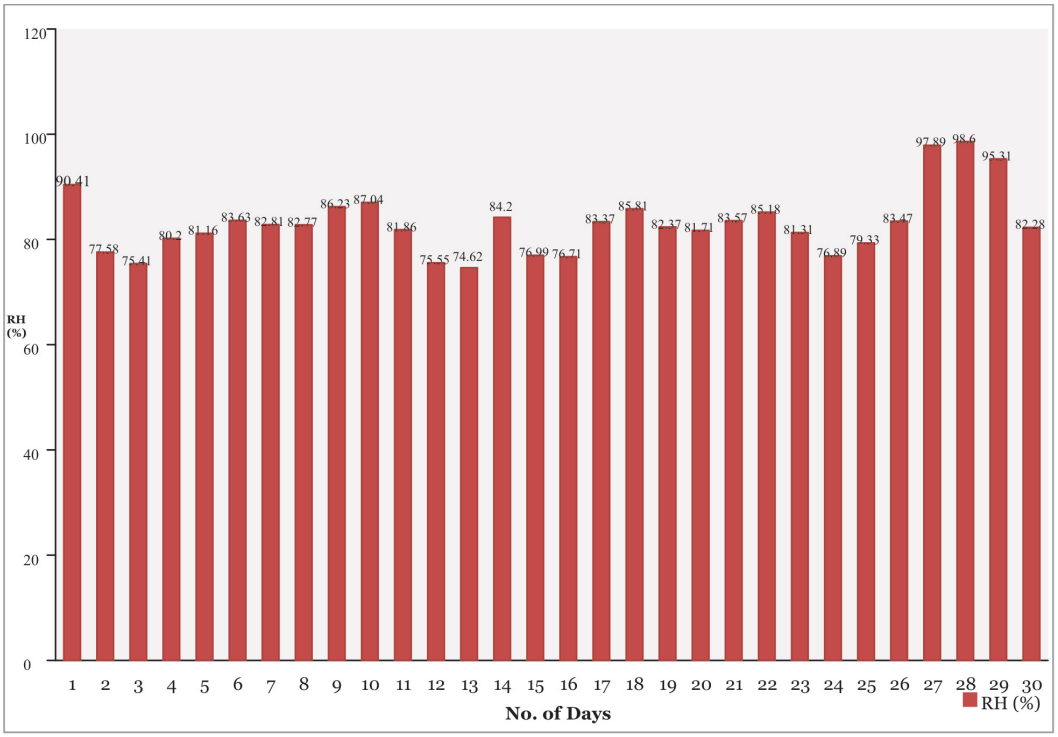

Fig. 4. Average Value of Relative Humidity (°) of 30 Days

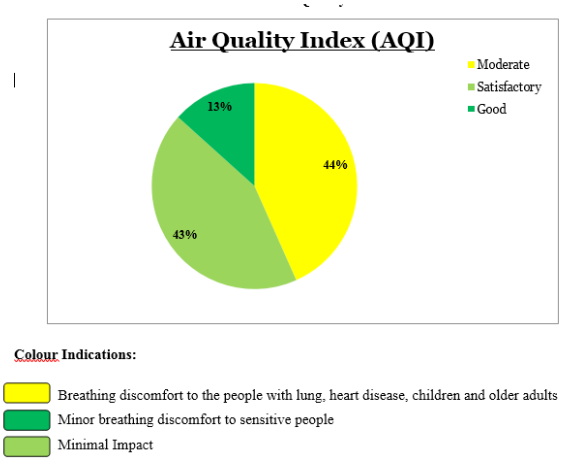

Fig. 5. Air Quality Index CAAQMS (BSARIST, Vandular) during April 2023

Factor analysis: A variety of significant variables, such as air quality and health, can be combined, and factor analysis is a useful tool for extracting the latent or underlying elements. The appropriateness of factor analysis is shown by high scores between 0.5 and 1.0. Values below 0.5 suggest that factor analysis might not be suitable. The values of factor loading connected with the Table 2, 3, 4 as Global Warming, Climate Change, Acid Rain, Deterioration of fields, Respiratory Health problems, Chemical Sensitivity, Skin Damage, Extinction of animal Species, Deterioration in Building Materials, Combustion of Carbon-Containing fuels, Gas Industrial Processes, Vehicular Emissions, and Volatilization from soils and oceans.

Table 3. KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.505
Bartlett's Test of Sphericity	Approx. Chi-Square	5.711
	df	3
	Sig.	.127

Table 3i. Total Variance Explained

Factors	Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
		Total Variance	% of	Cumulative %	Total	% of Variance	Cumulative %
Factors associated with • Global Warming • Climate Change • Acid Rain • Deterioration of fields	Ozone (O_3) Nitrogen Oxides (NOx) Sulfur Dioxide (SO_2)	1.467 .953 .579	48.914 31.774 19.312	48.914 80.688 100.000	1.467	48.914	48.914

*Extraction Method: Principal Component Analysis.

Factor Analysis-1

The possibility that the variables are associated is investigated using Bartlett's test of sphericity. It is based on the determinant of the correlation matrix's Chi-square transformation. A high test statistic result will favour rejecting the null hypothesis.

The Kaiser meyer olkin value, which is calculated using factor analysis, is found to be 0.74 Bartlett's test of sphericity chi-quare statistics is 5.711, which indicates that the 30 Days of air quality monitoring are correlated. As a result, factor analysis is suitable for the given data, as can be seen in Table 3.

The below Table 3(i) shows the details of factors associated with air pollution and total variance, which creates impact on air quality with three components (O_3, NOx and SO_2). The underlining factors such as global warming, climate change, acid rain and deterioration of fields with the data variables such as sulfur dioxide, nitrogen oxides, and ozone (O_3, NOx and SO_2) and the total variance of three factors considered through the initial eigen values and extraction sums of squared loadings in an exploratory analysis, the eigen value is calculated for each factor extracted and can be used to determine the number of factors to extract. a cutoff value of 1 is generally used to determine factors based on Eigen values (Sharma *et al.*, 2009). The below Table 3 (i) shows that there is no negative Eigen value and the cumulative is 48.914 percentage of the true value and connected with the three factors and the details of factors associated with Air Pollution and Total Variance, which creates Impact on Air Quality with three components (O_3, NOx and SO_2)

Factor Analysis-2

The Kaiser- Meyer- Olkin value, or 0.500, is deter-

Table 4. KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.500
Bartlett's Test of Sphericity	Approx. Chi-Square	63.920
	df	1
	Sig.	.000

mined by factor analysis. Bartlett's test of sphericity chi-square statistics, which reveals that the 30 Days of air quality monitoring are correlated, indicates that factor analysis is suitable for the supplied data and is shown in

The below Table 4 (i) shows the details of factors associated with Air Pollution and Total variance, which creates Impact on Air Quality with two components (PM_{10} and $PM_{2.5}$)

The below Table 4 (i) shows the details of factors associated with Air Pollution and Total Variance, which creates Impact on Air Quality with two components (PM_{10} and $PM_{2.5}$) The underlining factors such as respiratory health problems, chemical sensitivity, skin damage, extinction of animal species and deterioration in building materials can be estimated (Dhyani *et al.*, 2017) with the data variables such as particulate Matter (PM_{10}) and ($PM_{2.5}$) and the sum of the variances of the two variables that were taken into account using the initial Eigen values and extraction sums of squared loadings. The eigen value for each extracted factor in an exploratory study is determined and can be used to choose how many factors to extract. In most cases, factors based on Eigenvalues are determined using a cutoff value of 1. Table 3(i) above demonstrates that there is no negative Eigen value and that the cumulative is related with the two factors and 97.491 percent of the genuine value.

Factor Analysis-3

The Kaiser-Meyer-Olkin value is determined by factor analysis to be 0.500, and Reliability value of multi collinearity chi-square values is 18.484. It indicates that the 30 Days of air quality monitoring are correlated and hence as inferred in KMO, factor analysis is appropriate for the given data it can be seen in Table 5. The below Table 5(i) shows the details of factors associated with Air Pollution and Total Variance, which creates Impact on Air Quality with two components (CO and NH_3).

Table 5. KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.500
Bartlett's Test of Sphericity	Approx. Chi-Square	18.484
	df	1
	Sig.	.000

The below Table 5 (i) shows the details of factors associated with Air Pollution and Total Variance, which creates Impact on Air Quality with two components (CO and NH_3).

The Underlining factors such as Combustion of carbon containing fuels, Gas industrial processes, Vehicular emissions and Volatilization from soils and oceans with the data variables such as Carbon Monoxide (CO) and Gaseous Ammonia (NH_3) the sum of the squared loadings and initial eigenvalues, which take into account the total variance of two components. The eigen value for each extracted factor in an exploratory study is determined and can be used to choose how many factors to extract. In most cases, factors based on eigenvalues are determined using a cutoff value of 1. The cumulative value is 84.978 percent of the true value and connected to the

Table 4i. Total Variance Explained

Factors	Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
		Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
Factor associated with • Respiratory health problems • Chemical Sensitivity • Skin Damage • Extinction of animal species • Deterioration in building materials	**Particulate Matter (PM10)** **Particulate Matter (PM2.5)**	1.950 .050	97.491 2.509	97.491 100.000	1.950	97.491	97.491

*Extraction Method: Principal Component Analysis.

two factors, as shown in Table 4(i) above, and there is no negative Eigen value.

The sum of the variance explained by each factor is represented by its Eigen Value. percentage of the overall variance that each component contributed. Principal Component Analysis, which takes into account the entire variation in the data to identify the bare minimum of factors that will account for the highest variance of the data, is one of the well-liked techniques used in exploratory factor analysis.

AQI and vehicular movement correlation

It is interesting to analyze the vehicular movement near the station. An attempt has been made to check the correlation between pollution levels and number of vehicles through simple analysis. The data acquired on vehicle movement close to our institute between 20-4-23 to 20-5-23 has been presented. During this period, the vehicular movement is minimum due to Covid Lock down restrictions. This way it is interesting to see and compare with AQI with vehicle Movement During the Month of April (20-4-2023 to 30-4-2023) From the above data (Fig. 6), the following observations can be made.

The vehicle traffic on 27-4-23 is very high with 66 movements, b) the second Maximum is on 29-4-23. The total number of vehicles is 47, c) the minimum number of vehicles is on 25-4-23, d) the second minimum number of vehicles falls on 28-4-23.

The monitoring station is located between Vandalur on one side and Kelambakkam on the other side. In the table and chart (Fig. 7) below the vehicle movement from two different directions are presented. It may be observed that, a) Total number of vehicles towards Kelambakam is more compared to Vandalur on 27-4-23, b). The number of vehicles towards Kelambakam is 51 and the number of vehicles towards Vandalur is 15, c) on 29-4-23, the total number of vehicles towards Vandalur is more compared to Kelambakam. The number of vehicles towards Vandalur is 30 and the number vehicles towards Kelambakam is 17.

We also made analysis of the vehicular movement for 20 days during May. Here are the observations from the vehicle movement (Fig. 8) during the Month of May (01.5.2023 to 20.05.2023) as described below. Observations from the above data are a) on 15.5.23, the total number of vehicles are more which is 36, b) similarly, the total number of vehicles is 36 on 5-4.23, c) the vehicles movement are less on 01.05.23 and 02.05.23, Observations from the above Figure 9 are a) the number of vehicles towards Kelambakam is more compared to Vandalur which

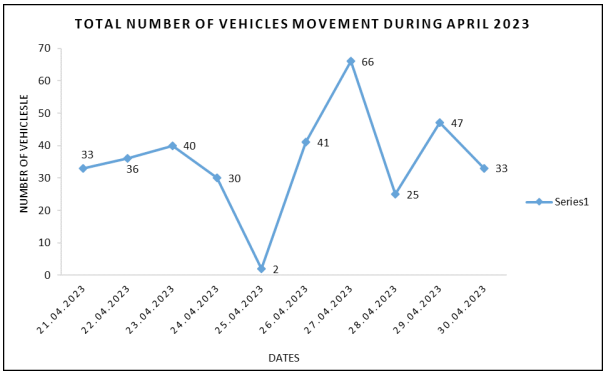

Fig. 6. Total Number of Vehicles during April 2023 for sample of 10 Days

Table 5i. Total Variance Explained

Factors	Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
		Total Variance	% of	Cumulative %	Total	% of Variance	Cumulative %
Factor associated with	**Carbon Monoxide (CO-mg/m³)**	1.700	84.978	84.978	1.700	84.978	84.978
• Combustion of carbon-containing fuels (such as gasoline, natural gas, oil, coal, wood)							
• Gas industrial processes	**Gaseous Ammonia (NH_3)**	.300	15.022	100.000			
• Vehicular emissions							
• Volatilization from soils and oceans.							

*Extraction Method: Principal Component Analysis.

is 27 on 5-10-23, b) the number of Vehicles towards Vandalur is only 2 on the same day, c) the next maximum falls on 3 days on 5-13-23, 5-15-23 and 5-17-23.

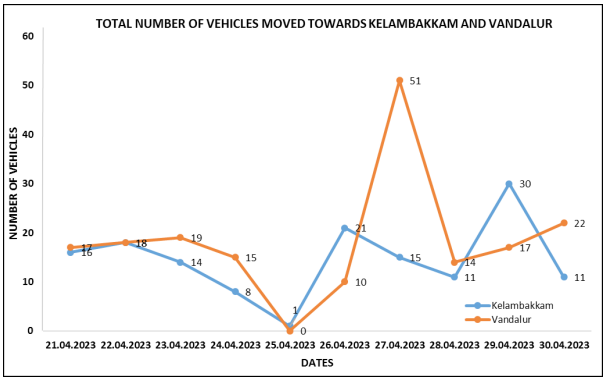

Fig. 7. Total Number of Vehicles running towards Kelambakkam and Vandalur during April 2023 for sample of 10 Days

The number of vehicles towards Kelambakkam is 24. The number of vehicles towards Vandalur is 5,12 and 2 on the same day. The good correlation of vehicle movement and pollution parameters can be clearly observed. Further all these observations are more clearly seen and can be correlated with different measured parameters. For this purpose, 3D representation of the 12 data parameters for 3 months are presented in the figure 10. In Figures 10, we present 12 measured parameters in 3D representation for a duration of 3 months during 1st Feb. to 30th Apr. 2023. The data can be seen for easy visual comparison, observation and qualitative analysis. They are NO_2: Nitrous Oxide in (µg/m^3), NH_3: Ammonia in (µg/m^3), particulate matter - PM_{21} (µg/m^3), particulate matter –$PM_{2.5}$ (µg/m^3), Carbon Monoxide – CO (µg/m^3), Sulphur Dioxide - SO_2(µg/m^3), Ozone-O3 (µg/m^3), Wind speed –WS (m/s), wind direction –wd (In degrees from North), atmospheric temperature AT (in centigrade), relative humidity-RH in percentage, barometric pressure –bp in mbar,

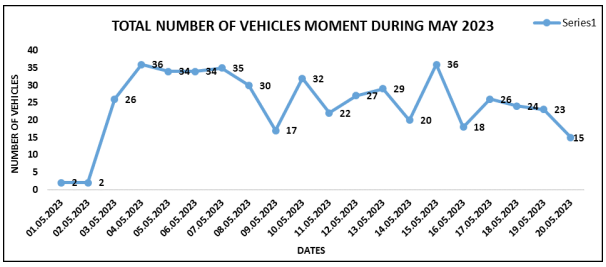

Fig. 8. Total Number of Vehicles during May 2023

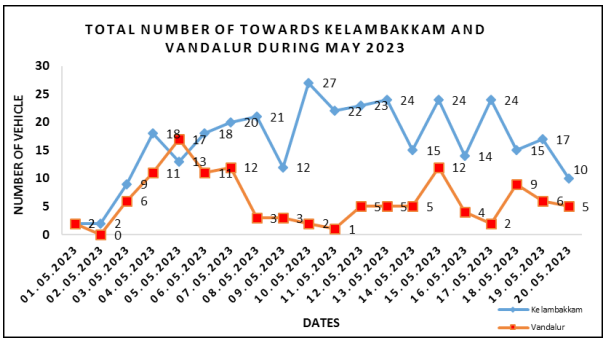

Fig. 9. Total Number of towards kelambakkam and vandalur during May 2023

Rain in millimeter. Here X-axis represents the local time; Y-axis represents the number of days, and Z-axis the variable parameter. A few general observations one can derive from these figures are- a) a few parameters are showing daily variation and follows the local time. b) some parameters have shown good correlation with local vehicular movement c) during rainy day, all the particle matter $PM_{2.5}$ and PM_5 have shown significantly low value indicating that weather plays an important role in air pollution etc.

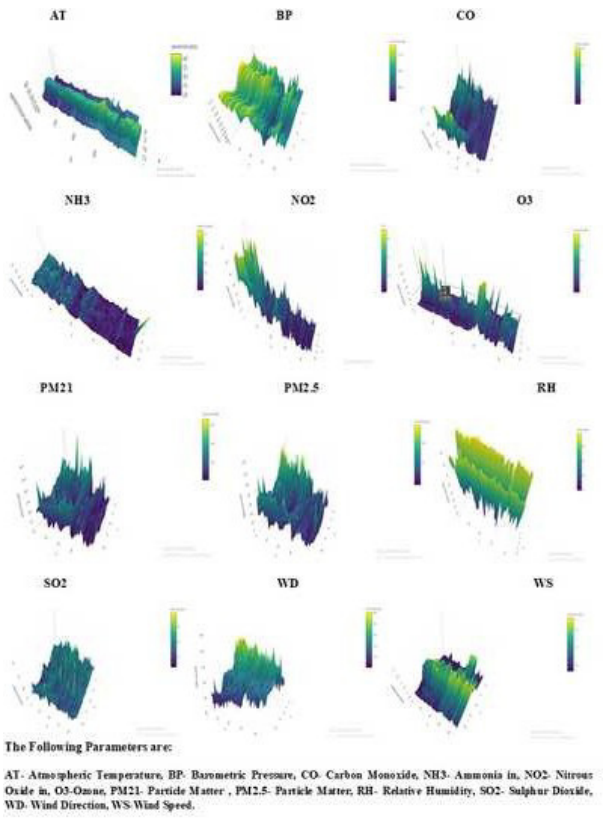

Fig. 10. Parameters index of O3, NO2 and SO2

Conclusion

We analyzed the limited air parameters data available with us at the permanent monitoring station with air quality sensors located at BS Abdur Rahman Crescent Institute of Science and Technology, Vandalur, Chennai. This station is working well and producing the data for pollution control board of Govt. of Tamil Nadu and also acting as a research facility to the faculty and students for their general research and knowledge along with data analysis.

The present air quality data analysis duration pertains from Oct. 2020 to Nov. 2020 and also from Feb. 2023 to April 2023 related to air quality data. Additionally, a few days during the month of April 2023 related to vehicular movement data is also analyzed near the sensors. From the overall assessment of the air parameters data in different periods, especially the AQI, the Vandalur area falls from good to moderate level that corresponds to less than 200 AQI. We observed that air quality is directly related to weather parameters.

During high wind, rain and stormy days, general atmosphere is of high quality. This is mainly due to pollutants are either absorbed or blown away. From different 3D representation of air pollution parameters, it is observed that they have exhibited regular local time variation more or less exhibiting similar pattern on all days from 3 months' duration of the data except a small deviation in few days. From the limited vehicular movement data, it is observed that moderate level pollutants are directly related to the traffic and their movement. There is no other element responsible for the air pollution in Vandalur area although cement and other factories are located about 5 km away from the region. From this analysis one can conclude that air pollution in the area falls under good to moderate level and even the moderate level depends directly on the vehicle movement only and no other industry pollutants apparent. This way, the animals living in the nearby Zoo and their health is quite safe along with human beings living in the area as compared to other regions of Chennai. To maintain the same level in the coming years, it is suggested to increase the density of the plants on both the sides of the road and also in the open area available in the nearby zoo. This is essential as there is a crisis cross of flyover junctions, bus stations etc. are being established and number of vehicles are likely to increase in the coming years. Additionally, we need to protect the animals living permanently in the Zoo apart from transit human beings.

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