Air Quality Analysis

Introduction:-

Air quality analysis is the process of assessing the level of pollutants and contaminants present in the air. It is crucial for understanding the potential health risks associated with breathing polluted air and for making informed decisions to protect ourselves and the environment.

Air quality analysis involves measuring various pollutants such as particulate matter (PM), ozone (O3), nitrogen dioxide (NO2), sulfur dioxide (SO2), carbon monoxide (CO), and volatile organic compounds (VOCs). These pollutants can come from various sources, including industrial emissions, vehicle exhaust, agricultural activities, and natural sources like wildfires.

By conducting regular air quality analysis, policymakers can identify areas with poor air quality and implement measures to reduce pollution. Individuals can also use the information to make decisions about outdoor activities, such as exercising or spending time in polluted areas.

Overall, air quality analysis plays a crucial role in protecting public health and the environment by providing valuable information about the quality of the air we breathe.

Once the innovation is introduced, continuous monitoring of air quality should be conducted to assess its impact. This can be done by comparing the post-implementation data with the baseline data collected earlier. Any changes in pollutant levels and trends can indicate the effectiveness of the innovation in reducing emissions and improving air quality.

Additionally, it is important to consider the indirect effects of the innovation on air quality. For example, if the introduction of a new public transportation system leads to a reduction in private vehicle usage, it can result in decreased traffic congestion and subsequently lower emissions from cars. These indirect effects should also be taken into account when evaluating the overall impact on air quality.
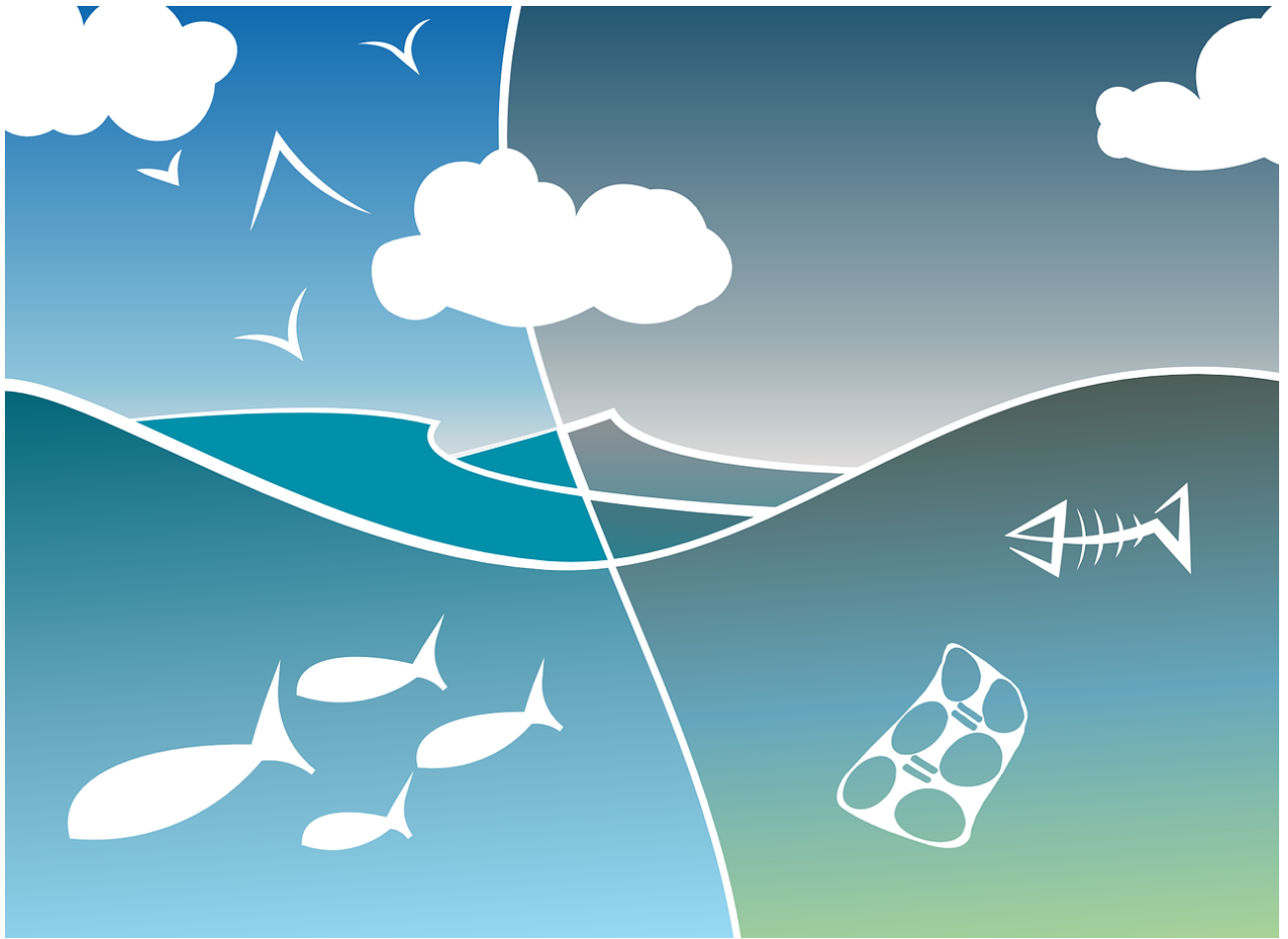
Problem statement:-

The problem statement for air quality analysis could be: "The air quality in many regions is deteriorating due to increasing pollution levels, posing significant health risks to the population.

There is a need for accurate and timely analysis of air quality data to understand the extent of pollution and develop effective strategies to mitigate its impact on public health and the environment.

Abstract

Background:-

Air pollution affects both the health of living being and the materialistic resources. Amid the development of anthropogenic methods and machines, atmosphere has turned as a sink for foul gases and disorderly energy.

Air pollutant discharges have deteriorated the natural composition of air in atmosphere at spatial manner.

Method:-

The resulting losses from air pollutants can be minimized either by control at source (through air pollution control devices) or by diverting the receptor from pollution prone area.

The second option requires an exact estimation of air pollutant's concentration, which can be done by use of air pollution forecast models.There are many simulation models for forecasting the air pollutant concentration at any place.

However, the results of these models are questioned many times because of inappropriate forecasting.

Scope and structure of the review:-

The scope and structure of the air quality analysis for the introduction of innovative public

transportation should be well-defined to ensure a comprehensive assessment. The review

should consider the following elements:-

1. Objectives: Clearly define the objectives of the air quality analysis, such as evaluating the impact of the innovative public transportation solution on pollutant levels and identifying potential improvements in air quality.

2. Study Area: Specify the geographical area where the analysis will be conducted. This could be a specific city, region, or even a neighborhood where the innovation is being implemented.

3. Baseline Data Collection: Collect baseline data on air quality before the implementation of the innovative public transportation system. This data should include information on pollutant levels, meteorological conditions, and any other relevant factors that may affect air quality.

4. Air Quality Indicators: Identify and select specific air quality indicators to measure throughout the analysis. These indicators may include particulate matter (PM), nitrogen oxides (NOx), carbon monoxide (CO), volatile organic compounds (VOCs), and other pollutants that are relevant to the area and transportation system being evaluated.

5. Monitoring Stations: Determine the locations and number of monitoring stations needed to capture real-time data on pollutant levels. These stations should be strategically placed to ensure representative measurements and cover areas of interest, such as busy roadways or areas with high population density.

6. Data Collection and Analysis: Implement a data collection plan to monitor pollutant level continuously after the introduction of the innovative public transportation system.Compare this post-implementation data with the baseline data collected earlier to assess any changes in pollutant levels and trends.

7. Direct and Indirect Effects: Consider both the direct and indirect effects of the innovative public transportation system on air quality. Evaluate the reduction in emissions from the transportation system itself, as well as any potential indirect effects, such as changes in private vehicle usage or traffic congestion.

8. Evaluation and Recommendations: Analyze the data collected and evaluate the overall impact of the innovative public transportation system on air quality. Based on the findings,provide recommendations for further improvements or adjustments to enhance air quality.

9. Reporting: Prepare a comprehensive report summarizing the air quality analysis, including methodology, data collected, findings, and recommendations. This report

should be accessible to decision-makers, stakeholders, and the general public to ensure transparency and facilitate informed decision-making.

By following a well-defined scope and structure for the air quality analysis, decision-makers can gain valuable insights into the effectiveness of innovative public transportation solutions in improving air quality and make informed decisions to promote sustainable urban development.

Air pollution sources and emissions:-

In order to conduct a comprehensive air quality analysis for the introduction of innovation public transportation, it is important to consider the various sources of air pollution and their emissions. This will help in understanding the potential impact of the transportation system on air quality. Some common sources of air pollution include.

Smart-Air:-

An accurate data measurement of indoor air quality is the most important factor for the platform. Thus,Smart-Air was developed to collect accurate and reliable data for indoor air quality monitoring.

Because the monitoring area is not constant, the device was designed to be easily customized to an environment by using an expandable interface. Thus, various types of sensors can be installed or adjusted based on the environment. Also, a Long-Term Evolution (LTE) modem is mounted in the device to transmit detected data directly to the web server for classifying and visualizing air quality. For Most Iot platforms, gateway or data loggers are installed to gather and transmit data wirelessly to the web server. However, in this study, a microcontroller was installed in the device to gather the data from the sensors and transmit it to the web server using the LTE modem, eliminating the need for a gateway and a data logger.
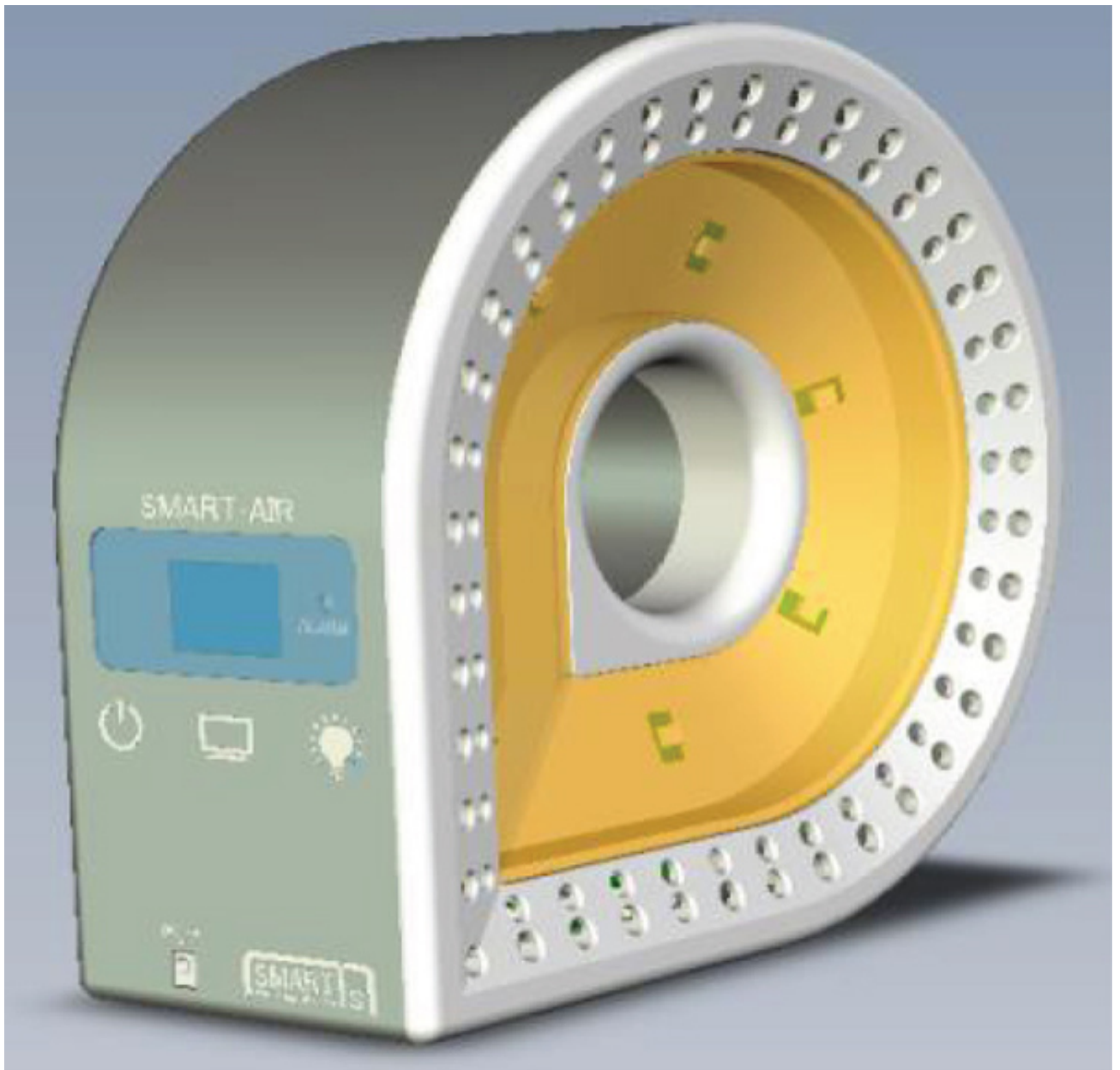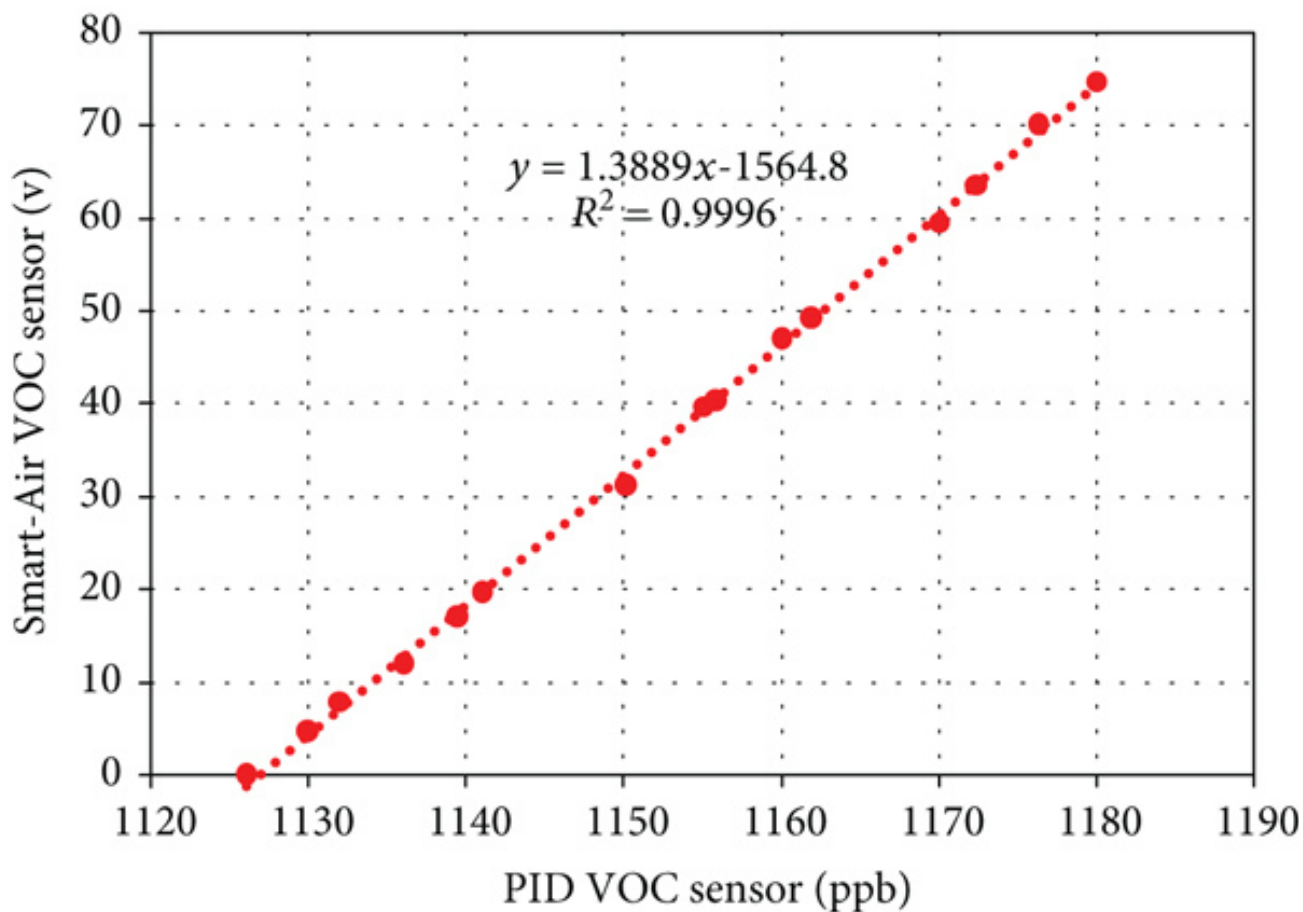
The most important purpose of Smart-Air is to precisely detect air quality in the perception layer of the platform that a primitive concept design of the device is shown in Figure

This device has an expandable interface such that multiple sensors can be installed simultaneously or easily added according to monitoring requirements. In the present study, the Smart-Air device consists of a laser dust sensor, a volatile organic compound (VOC) sensor, a carbon monoxide (CO) sensor, a carbon dioxide (CO_2) sensor, and a temperature-humidity sensor. Moreover, an LED strip was installed in the center of the device to visualize air quality using colors. When the quality of air changes, the device's LED changes color and wirelessly sends an alert message to the web server via LTE. Thus, the LTE modem transmits and receives data by communicating with the web server for detailed monitoring and determination of air quality as the presentation layer of the platform.
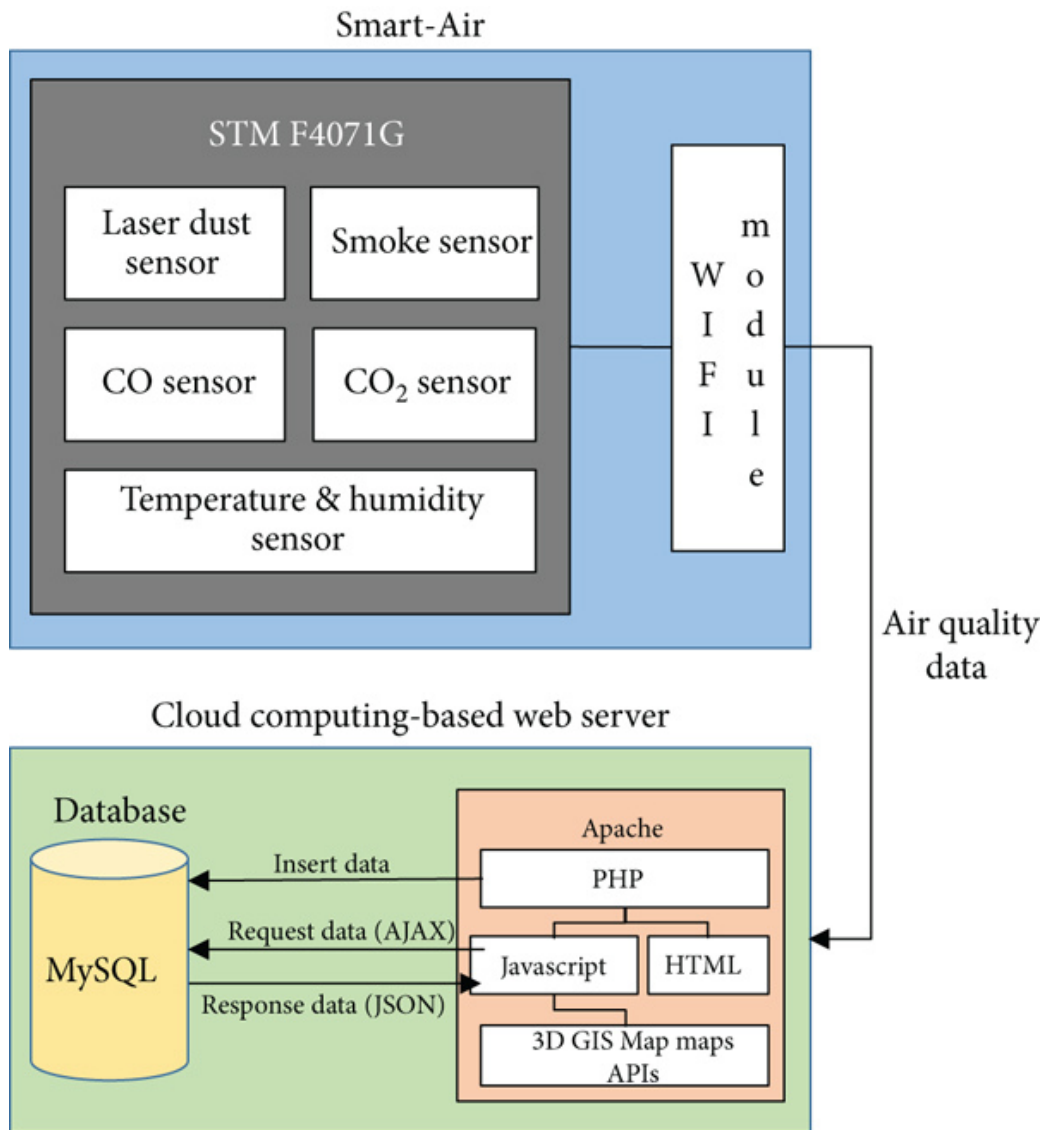
The figure shows a scatter plot with linear fit:

$$y = 1.3889x - 1564.8$$
$$R^2 = 0.9996$$

X-axis: PID VOC sensor (ppb), ranging from 1120 to 1190.
Y-axis: Smart-Air VOC sensor (v), ranging from 0 to 80.

An IoT-Based Indoor Air Quality Monitoring Platform :-

The IoT-based indoor air quality monitoring platform is primarily divided (Figure) into the Smart-Air and the web server. The set of sensing devices necessary to collect the data to analyze air quality comprised a laser dust sensor, a CO sensor, a CO2 sensor, a VOC sensor, and a temperature and humidity sensor. Each device transmitted data to the web server via the LTE module to determine air quality and visualize the result. Furthermore, cloud computing technology was integrated with a web server. The main benefits of the cloud computing-based web server are faster speed, flexibility, and greater accessibility. The web server provided faster and more flexible data processing functions with a large amount of data, which is essential for a monitoring platform. The cloud computing-based web server is easily accessible through most browsers to allow ubiquitous monitoring. In this study, Amazon Web Services (AWS) was used as the web server to analyze, visualize, and present the data collected from Smart-Air. Also, the web server provides a database to store that data in the cloud. Furthermore, a mobile application was developed for the system to visualize air quality with the web server "anywhere, anytime" in real time.

Smart-Air

STM F4071G

Laser dust sensor | Smoke sensor

CO sensor | CO_2 sensor

Temperature & humidity sensor

WIFI module

Air quality data

Cloud computing-based web server

Database

MySQL

Insert data
Request data (AJAX)
Response data (JSON)

Apache

PHP

Javascript | HTML

3D GIS Map maps APIs

Conclusion:-

In conclusion, air quality analysis plays a crucial role in assessing and understanding the state of air pollution. By measuring and evaluating pollutant levels, identifying pollution sources, and predicting future air quality, it helps in developing targeted strategies to reduce emissions and control pollution. Additionally, it informs policy and decision-making processes, ensuring that effective measures are implemented to improve air quality and protect public health and the environment.

The selection and use of specific evaluation criteria and their ability to interpret the results varies with the study area, prevailing meteorological conditions, formulation of model structure and behaviour of observed data and simulation results. A suitably selected performance criteria help in designing the best deliverable air pollution forecast model.