**Integration Documentation**

**Project Overview:**

This project focuses on monitoring and analyzing air pollution in urban areas to support Sustainable Development Goal (SDG) 13: Climate Action. The project involves designing a relational database, collecting and storing data, performing data analysis, and visualizing the results in Microsoft Excel.

**System Components:**

1. **Database Design:**
   * MySQL relational database
   * Tables: Stations, Pollutants, Measurements, Weather
2. **Data Sources:**
   * CSV files containing data for stations, pollutants, measurements, and weather
3. **Data Analysis Tools:**
   * SQL queries for data retrieval and analysis
   * Microsoft Excel for data visualization and reporting

**Integration Steps:**

**Step 1: Database Setup**

1. **Install MySQL:**
   * Download and install MySQL from the official website.
   * Follow the installation instructions and set up the MySQL server.
2. **Create Database:**
   * Open MySQL Workbench or any MySQL client.
   * Create a new database

CREATE DATABASE air\_pollution\_monitoring;

USE air\_pollution\_monitoring;

1. **Create Tables:**
   * Define the schema and create the necessary tables:

-- Create Stations table

CREATE TABLE Stations (

StationID INT AUTO\_INCREMENT PRIMARY KEY,

StationName VARCHAR(100) NOT NULL,

Location VARCHAR(100),

Latitude DECIMAL(9,6),

Longitude DECIMAL(9,6)

);

-- Create Pollutants table

CREATE TABLE Pollutants (

PollutantID INT AUTO\_INCREMENT PRIMARY KEY,

PollutantName VARCHAR(50) NOT NULL,

Description TEXT

);

-- Create Measurements table

CREATE TABLE Measurements (

MeasurementID INT AUTO\_INCREMENT PRIMARY KEY,

StationID INT,

PollutantID INT,

MeasurementDate DATE,

MeasurementValue DECIMAL(10,2),

FOREIGN KEY (StationID) REFERENCES Stations(StationID),

FOREIGN KEY (PollutantID) REFERENCES Pollutants(PollutantID)

);

-- Create Weather table

CREATE TABLE Weather (

WeatherID INT AUTO\_INCREMENT PRIMARY KEY,

StationID INT,

Date DATE,

Temperature DECIMAL(5,2),

Humidity DECIMAL(5,2),

WindSpeed DECIMAL(5,2),

FOREIGN KEY (StationID) REFERENCES Stations(StationID)

);

**Step 2: Data Import**

1. **Prepare CSV Files:**
   * Ensure CSV files (stations.csv, pollutants.csv, measurements.csv, weather.csv) are formatted correctly.
2. **Import Data into MySQL:**
   * Use MySQL's LOAD DATA INFILE command to import data from CSV files:

-- Import data into Stations table

LOAD DATA INFILE 'C:/Users/YourUsername/Desktop/stations.csv'

INTO TABLE Stations

FIELDS TERMINATED BY ','

ENCLOSED BY '"'

LINES TERMINATED BY '\n'

IGNORE 1 ROWS;

-- Import data into Pollutants table

LOAD DATA INFILE 'C:/Users/YourUsername/Desktop/pollutants.csv'

INTO TABLE Pollutants

FIELDS TERMINATED BY ','

ENCLOSED BY '"'

LINES TERMINATED BY '\n'

IGNORE 1 ROWS;

-- Import data into Measurements table

LOAD DATA INFILE 'C:/Users/YourUsername/Desktop/measurements.csv'

INTO TABLE Measurements

FIELDS TERMINATED BY ','

ENCLOSED BY '"'

LINES TERMINATED BY '\n'

IGNORE 1 ROWS;

-- Import data into Weather table

LOAD DATA INFILE 'C:/Users/YourUsername/Desktop/weather.csv'

INTO TABLE Weather

FIELDS TERMINATED BY ','

ENCLOSED BY '"'

LINES TERMINATED BY '\n'

IGNORE 1 ROWS;

**Step 3: Data Retrieval and Analysis**

1. **Write SQL Queries:**
   * Retrieve and analyze data relevant to your SDG problem definition.
   * Example queries:

-- Retrieve CO2 measurements from Station1

SELECT m.MeasurementID, m.StationID, s.StationName, m.PollutantID, p.PollutantName, m.MeasurementDate, m.MeasurementValue

FROM Measurements m

JOIN Stations s ON m.StationID = s.StationID

JOIN Pollutants p ON m.PollutantID = p.PollutantID

WHERE p.PollutantName = 'CO2' AND s.StationName = 'Station1';

-- Calculate average CO2 levels

SELECT AVG(MeasurementValue) AS AverageCO2Level

FROM Measurements

WHERE PollutantID = (SELECT PollutantID FROM Pollutants WHERE PollutantName = 'CO2');

1. **Export Data to CSV:**
   * Export query results to CSV files for further analysis in Excel:

SELECT \* FROM Measurements

INTO OUTFILE 'C:/Users/YourUsername/Desktop/measurements\_export.csv'

FIELDS TERMINATED BY ','

ENCLOSED BY '"'

LINES TERMINATED BY '\n';

**Step 4: Data Visualization in Excel**

1. **Import CSV Files into Excel:**
   * Open Excel and import the CSV files containing the exported data.
   * Use the “Data” tab and select “From Text/CSV” to import each file.
2. **Create Data Visualizations:**
   * Use pivot tables, charts, and other Excel features to visualize the data.
   * Examples of visualizations:
     + Time series charts showing pollutant levels over time.
     + Correlation charts between weather conditions and pollutant levels.
     + Bar charts comparing pollutant levels across different stations.
3. **Generate Reports:**
   * Compile the visualizations and analysis results into comprehensive reports.
   * Use Excel's formatting tools to create professional and easy-to-read reports.

#### ****Conclusion:****

This integration document provides a step-by-step guide to set up a MySQL database, import data, perform SQL-based data analysis, and visualize the results in Excel. By following these steps, you can effectively monitor and analyze air pollution levels, contributing to the achievement of SDG 13: Climate Action.