

# Investigating Key Success Factors for EU Air Quality Compliance in Urban Areas: A focus on road transport

## Introduction

Air pollution remains a pressing environmental and public health challenge, particularly in urban areas across Europe. Nitrogen dioxide (NO<sub>2</sub>) emissions from road transport significantly contribute to this issue, necessitating effective strategies for meeting EU air quality regulations at the municipality level. This proof-of-concept project aims to investigate the key success factors influencing air quality compliance in urban settings, offering an exciting opportunity for MSc students interested in environmental science, data analysis, and policy research.

## Objective

The primary objective of this project is to identify and analyse the key success factors that contribute to meeting EU air quality regulations, specifically focusing on NO<sub>2</sub> emissions from road transport in large European cities. By examining the interplay between various conditions such as road actions, total vehicle numbers, public awareness, and economic incentives for low-emission vehicles, we aim to elucidate effective strategies for improving air quality and mitigating the adverse health effects of air pollution.

## Methodology

The research methodology involves a multifaceted approach, integrating both quantitative and qualitative analyses. First, data mining techniques, including the incorporation of a Large Language Model (LLM) for comprehensive information extraction and analysis, will be employed. The LLM will be used to analyse textual data and extract relevant information about road actions and transportation policies. It will parse complex documents and identify key details regarding the implementation, scope, and impact of road actions. Additionally, keyword extraction, topic modelling, and correlation analysis using the LLM will be conducted to identify patterns, trends, and relationships within the data.

Secondly, the project will make use of Bayesian Network Analysis (BNA) for exploring complex causal relationships. Bayesian Network Analysis offers a powerful tool for modelling uncertainties and dependencies among variables, providing insights into the interplay of factors influencing air quality compliance. By constructing Bayesian networks based on available data, the project aims to elucidate the causal mechanisms driving air quality outcomes in urban areas.

Furthermore, a critical component of the methodology involves conducting a time series analysis spanning from 2010 to 2023. This longitudinal approach enables the examination of temporal trends and dynamics in air quality parameters, including NO<sub>2</sub> concentrations and relevant socio-economic indicators. By analyzing

data over an extended period, the project seeks to identify long-term patterns, assess the effectiveness of past interventions, and forecast future air quality trajectories.

### **Data Collection:**

Governance: Gather data from diverse sources, including government reports, urban planning documents, transportation authority websites, news articles, academic papers, and environmental databases. Collect information on road actions such as low emission zones, urban road tolls, and congestion charges implemented in cities across Western Europe.

Air Quality and Emissions: Data will be collected from the European Environment Agency's Air Quality e-Reporting database, encompassing annual mean NO<sub>2</sub> concentrations from urban traffic monitoring stations and relevant socio-economic indicators. Through systematic data analysis and interpretation, the project will generate valuable insights into the determinants of air quality compliance at the municipality level.

## **Expected Outcomes**

- Identification of key success factors for meeting EU air quality regulations in urban areas.
- Quantification of the relative importance of different conditions in mitigating NO<sub>2</sub> emissions from road transport.
- Development of actionable recommendations for policymakers, urban planners, and environmental stakeholders to enhance air quality management strategies.
- Contribution to the advancement of knowledge in environmental science and policy research, with potential implications for sustainable urban development and public health.

## **Opportunities for MSc Students**

This project offers an excellent opportunity for MSc students to gain hands-on experience in environmental data analysis, statistical modelling, and policy evaluation. Students will have the chance to work with real-world air quality data, engage in interdisciplinary research collaborations, and contribute to impactful solutions for addressing pressing environmental challenges. Additionally, students will receive mentorship and guidance from experienced researchers, providing a supportive learning environment conducive to professional growth and academic achievement.

## **Conclusion**

In conclusion, this proof-of-concept project presents an exciting opportunity for MSc students passionate about environmental science, sustainability, and policy research to make meaningful contributions to air quality management and public health improvement efforts in urban areas. By investigating key success factors for EU air quality compliance, students will play a vital role in shaping evidence-based policies and interventions aimed at creating healthier and more sustainable cities for current and future generations. By leveraging data mining techniques, including the integration of a Large Language Model, this research aims to contribute valuable insights into the complex dynamics of air quality management in urban environments. Through comprehensive analysis and synthesis of information, we seek to empower stakeholders with evidence-based strategies for addressing air pollution and promoting sustainable urban development across Europe.