

THE STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT OF THE TRANSPORTATION SECTOR ON THE ROAD

إعداد



Introduction

Greater Cairo, one of the most populous metropolitan areas in the world, faces significant urban pollution. Urban pollution has become a critical global concern, particularly in densely populated metropolitan areas where rapid urbanization, industrialization, and motorized transportation have intensified environmental challenges. According to the World Health Organization (WHO), air pollution is responsible for 7 million premature deaths annually, with urban transport contributing significantly to poor air quality. Cities worldwide face high concentrations of nitrogen oxides (NOx), sulfur dioxide (SO₂), and particulate matter (PM), primarily originating from vehicle emissions, industrial activities, and inefficient urban planning.

Policy Options:

- Advocate for the development and expansion of a robust public transportation system in Greater Cairo.
- Share the model with stakeholders and decision-makers
- Use the findings from the monitoring system to adapt and improve policies over time.
- Regularly communicate the results to the public
- Highlight the long-term benefits of improved air quality.

The transportation sector on the road plays a fundamental role in urban mobility and economic growth; however, it remains a major contributor to air pollution, greenhouse gas (GHG) emissions, and climate change. The International Energy Agency (IEA) reports that road transport accounts for approximately 24% of global CO₂ emissions, with urban areas contributing a substantial share. In Greater Cairo (GCR), vehicular emissions constitute nearly 40% of total air pollutants, significantly impacting public health and environmental sustainability.

Metropolitan regions such as Greater Cairo, New Delhi, and Beijing have witnessed alarming pollution levels due to increased vehicle ownership, inadequate public transportation infrastructure, and inefficient land-use planning. Studies have shown that exposure to high levels of PM2.5 (fine particulate matter) can cause respiratory diseases, cardiovascular problems, and reduced life expectancy. In Cairo, PM10 concentrations exceed WHO limits by more than five times, making air pollution one of the most pressing environmental issues ((WHO), World Health Organization, 2012/2013).

Given the severe environmental impact of transportation, there is an urgent need to re-evaluate public transportation policies and restructure land-use distribution to promote sustainable urban mobility. Policymakers must implement strategies such as Expanding and modernizing public transportation systems (bus rapid transit, metro networks), Encouraging the use of low-emission and electric vehicles (EVs) and Implementing road pricing and congestion charges to reduce private car dependency (Newman, P., & Kenworthy, J., 2015)

These models enable urban planners to forecast future emissions based on different policy scenarios, Assess the effectiveness of transport interventions in reducing pollution, Identify high-risk areas for targeted environmental policies. This study highlights the important role of

mathematical modeling in supporting environmentally sustainable transportation policies. The findings provide valuable insights for urban planners and policymakers in Greater Cairo, offering a scientific foundation for reducing emissions, optimizing public transport, and improving air quality. By implementing data-driven strategies, cities can transition towards cleaner, more efficient, and sustainable urban transport systems.

The selected study area for this research is the Greater Cairo Region (GCR), Egypt, which includes three sectors. The main sector is the metropolitan Cairo city on the eastern bank of the Nile River, parts of Giza City on the eastern bank of the Nile, and Qalyoubia, north of Cairo. The study area is located at $30^{\circ}00$ 'N and $31^{\circ}20$ 'E, in the middle and southern part, i.e. apex, of the Nile Delta Region, covering an area of 845,137 hectares (Figure 1).



Fig (1): Greater Cairo Region (GCR), Egypt Source: http://glovis.usgs.gov/2024

Develop a mathematical model and framework for assessing the potential environmental impacts of different transportation policies in GCR. For five types of vehicles (Cars, bus, trucks, motorcycle and taxi) on three types of read (atrial, residential and highway), through:

- Modeling the existing transportation system: This includes capturing traffic patterns, vehicle types, fuel consumption, and emissions.
- Simulating future scenarios: The model would be used to predict the environmental impacts of different transportation polices, such as expanding public transit, introducing electric vehicles, or implementing congestion pricing.
- **Comparing and evaluating options:** By analyzing the modeled outcomes, policymakers and stakeholders can compare different policies based on their environmental footprint, cost-effectiveness, and potential for improving public health and quality of life.

Key Findings:

• Screening and scoping: identify the problem related to the environmental impact of transportation in the Greater Cairo region. The goal should be defined to achieve a sustainable and efficient transportation system that minimizes the negative impact on the environment to Description and assessment of the surrounding environment using the stakeholder questions tool (SWOT analysis – risk assessment – cost benefit analysis).

- Impact assessment: The next step is to assess the environmental impacts of the proposed project. This includes identifying the direct, indirect, and cumulative impacts, as well as the positive and negative impacts. Identifying the environmental impact of the plan's components on environmental elements using checklist tool and literature review show that Greater Cairo is one of the most polluted cities in the world. The main sources of air pollution in the city are traffic emissions, industrial emissions, and dust from construction sites. Air pollution in Greater Cairo has been linked to a number of health problems, including respiratory diseases, heart disease, and cancer.
- Identify environmental risks associated with transport projects before implementation.
- Promote sustainable mobility by integrating eco-friendly solutions.
- Reduce negative social and economic impacts (e.g., displacement, pollution, congestion).
- Ensure stakeholder participation (communities, experts, policymakers).
- Align transportation policies with climate goals and international agreements.
- Develop a mathematical model and framework for assessing the potential environmental impacts of different transportation policies in GCR., through:
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The model can then be used to analyze the effects of different policies and interventions on the transportation system. This analysis can be used to help decision-makers make informed decisions about how to improve the transportation system.

In this study, three policies have been selected that could potentially mitigate air pollution in Greater Cairo according to studies and reports to the World Bank and Economic Research Forum (ERF):

- **Road Pricing**: by raising fuel prices, increasing licensing fees for vehicles, and imposing congestion or fuel charges to dissuade private car use (The World Bank, (2020).) And implement stricter vehicle emission standards for new and existing vehicles and discourage the use of older, more polluting vehicles through taxes or other financial incentives (Economic Research Forum (ERF)., 2017).
- Utilizing Renewable Energy: Promote the use of cleaner fuels, such as compressed natural gas (CNG) and electricity (Thomas, A.A., 2011) and fostering a shift to cleaner vehicles and enhancing vehicle maintenance by Encourage the adoption of cleaner vehicles like electric vehicles (EVs) and hybrid electric vehicles (HEVs) through incentives like tax breaks, subsidies, preferential parking. Implement regular vehicle inspection and maintenance programs to ensure vehicles are operating efficiently and within emission standards.
- Development of A Public Transportation System: Invest in expanding and improving public transportation options, such as buses, metros, and light rail, make public transportation more affordable and accessible, integrate public transportation with other transportation modes, such as walking and cycling, to make it easier for people to get around without using a car and Build and maintain safe and accessible infrastructure for pedestrians and cyclists.



It is important to note that the best policy for reducing air pollution will vary depending on the specific circumstances of each city or country. However, system dynamics can be used to evaluate the potential impacts of different policies and to identify the best policy for a given situation.

Conclusion

- System Dynamics Approach: it reveals the complex relationships between factors like car emissions, traffic, and air quality, showing how policies impact on the transportation ecosystem.
- **Policy Evaluation and Monitoring**: A mathematical model enables policymakers to evaluate and optimize transportation policies for maximum environmental benefit by assessing their impact on air pollution.
- **Public Transit:** The study identifies a robust public transit system as the most effective long-term solution to Cairo's air pollution problem due to its potential to reduce car emissions and traffic congestion.

Future Studies

- **Economic feasibility**: Future studies should assess the chosen policy's affordability, ensuring its economic viability for long-term implementation.
- **Integrated policy development**: Research efforts should explore creating a combined policy incorporating multiple suitable strategies for metropolitan areas, potentially leading to a more comprehensive approach to air pollution control.
- **Regional application:** Future research can investigate expanding regulations beyond Greater Cairo to neighboring cities, fostering a more holistic regional solution to air pollution.
- **Policy framework development:** The proposed model could be further refined by establishing a framework for formulating research-based policies, ensuring data-driven decision-making for effective air pollution management

Policy Options

- Advocate for the development and expansion of a robust public transportation system in Greater Cairo.
- Share the model with stakeholders and decision-makers to ensure transparency and encourage collaboration in developing effective policies.
- Use the findings from the monitoring system to adapt and improve policies over time.
- Regularly communicate the results to the public to build trust and transparency in the decision-making process.
- Highlight the long-term benefits of improved air quality, including better public health, reduced healthcare costs, and increased economic productivity.