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REDUCING ENVIRONMENTAL EMISSIONS IN URBAN TRANSPORT SYSTEMS: EVIDENCE FROM KHOREZM REGION, UZBEKISTAN

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Abstract. Urban transport systems constitute a fundamental component of economic activity and social connectivity; however, they simultaneously represent one of the largest sources of environmental pressure in urban areas. The rapid expansion of motorized transport has significantly increased air pollution, greenhouse gas emissions, noise levels, and energy consumption, particularly in developing countries. This study investigates environmental emissions associated with urban transport systems using the Khorezm region of Uzbekistan as a case study. Drawing on national statistical data and international methodological approaches, carbon dioxide (CO_2) emissions from public transport are assessed using emission factor and passenger-kilometer methods. The analysis demonstrates that a high dependence on conventional fuel-based vehicles remains a major contributor to urban emissions in the region. The findings indicate that expanding electric public transport, improving fuel quality standards, and increasing the modal share of public transport could substantially reduce environmental impacts. The results provide policy-relevant insights to support sustainable urban transport planning in Uzbekistan and comparable developing regions.

Keywords: urban transport systems, CO_2 emissions, environmental sustainability, public transport, Khorezm region, Uzbekistan

Introduction

Urban transport plays a critical role in enabling economic productivity, accessibility, and social interaction. At the same time, transport activities have become a major driver of environmental degradation, particularly in rapidly urbanizing regions. Emissions from road transport contribute significantly to air pollution, climate change, noise exposure, and excessive energy consumption, posing serious risks to human health and urban livability.

Globally, the transport sector accounts for approximately 25–30% of total carbon dioxide (CO_2) emissions, with road transport representing the dominant share. This trend is largely driven by increasing private vehicle ownership, urban sprawl, and insufficiently developed public transport systems. As a result, many cities face worsening air quality and growing environmental costs.

The main factors intensifying environmental problems in urban transport systems include rapid urbanization, strong dependence on private cars, inadequate public transport coverage, and reliance on fossil fuels. These challenges are particularly pronounced in developing countries, where motorization growth often outpaces infrastructure modernization.

In Uzbekistan, the number of registered vehicles has increased substantially over the past decade. While major cities have benefited from investments in metro expansion and bus fleet modernization, regional cities such as those in the Khorezm region continue to experience uneven transport development. Consequently, transport-related emissions remain a significant environmental concern. Addressing these challenges requires evidence-based analysis and the adoption of sustainable transport strategies aligned with international best practices.

International experience in sustainable urban transport

International experience demonstrates that environmental impacts from urban transport can be significantly reduced through targeted policy interventions. European countries such as Germany, France, and Sweden have prioritized public transport electrification, fuel efficiency standards,

and non-motorized transport infrastructure. Norway provides a prominent example, where electric vehicles dominate new car sales due to strong fiscal incentives.

In the United States, federal and local initiatives promote low-emission transport through subsidies, regulatory standards, and investments in cycling infrastructure. China has emerged as a global leader in electric public transport deployment, operating the world's largest fleet of electric buses. Japan has focused on hybrid and hydrogen-based technologies, complemented by highly efficient urban rail systems.

These international cases highlight the effectiveness of electrification, public transport prioritization, and reduced reliance on private vehicles in lowering transport-related emissions.

Research objectives and tasks

The primary objective of this study is to assess environmental emissions generated by urban transport systems and to identify sustainable mitigation measures based on international experience and national conditions.

The specific research tasks are:

- to examine the main environmental impacts associated with urban transport activities;
- to review international best practices in sustainable transport development;
- to assess the current state of urban transport in the Khorezm region of Uzbekistan;
- to compare national conditions with global experience;
- to formulate practical recommendations for reducing transport-related emissions.

Methodology

Emission factor method. This study applies the emission factor method, widely used by the U.S. Environmental Protection Agency and the European Environment Agency. Total emissions are estimated as:

$$E = F \times EF$$

where E represents total emissions, F denotes fuel consumption, and EF is the emission factor corresponding to the fuel type.

Passenger-kilometer method. The passenger-kilometer approach evaluates emissions relative to transport efficiency:

$$E = P \times D$$

where P is the number of passengers and D is the distance traveled.

Life Cycle Assessment. Life Cycle Assessment (LCA) considers emissions generated throughout the entire life cycle of transport systems, including production, operation, maintenance, and disposal. While LCA is widely applied in developed countries, this study primarily relies on emission-based calculations due to data availability in the regional context.

Discussion

Comparison with international studies

International studies indicate that increasing the share of public transport and electrification can reduce urban transport-related CO_2 emissions by 20–30%. In contrast, Uzbekistan remains highly dependent on private vehicles, which account for the majority of urban emissions. Empirical evidence suggests that increasing public transport usage by 1.5 times could lower urban air pollution levels by up to 20%.

Environmental benefits of electric public transport

The introduction of electric buses and the restoration of trolleybus systems offer multiple benefits:

- a potential 40–60% reduction in CO_2 emissions;
- lower long-term operational and maintenance costs;
- significant reductions in noise pollution;
- support for regional green economy and climate objectives.

For the Khorezm region, compact urban structure and favorable renewable energy potential further strengthen the case for electric public transport adoption.

Conclusion

The results of the study indicate that:

- more than 70% of transport-related emissions in Uzbekistan originate from road transport;
- increasing private vehicle ownership in the Khorezm region has intensified environmental pressure;
- transport emissions account for approximately 30–35% of total regional CO_2 emissions;
- introducing electric buses and trolleybus systems could reduce emissions by 20–25%;
- international experience confirms that gradual transition to sustainable transport yields both environmental and economic benefits.

Practical recommendations

- Gradual implementation of electric and hybrid public transport vehicles;
- Improvement of public transport affordability and service quality;
- Introduction of "green zone" policies to limit private vehicle use in city centers;
- Optimization of bus routes and replacement of outdated vehicles;
- Development of public–private partnerships for charging infrastructure and cycling facilities.

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