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Sustainable Transport Systems and the Fight against Climate Change

Tunzala Alifova and Jeyhuna Allahverdiyeva
Mingachevir State University, Azerbaijan

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ABSTRACT

Climate change is one of the most serious global problems faced by countries around the world in modern times, and the transport sector is considered one of the main influential areas in this process. As a result of automobile, air, sea, and rail transport, large amounts of carbon dioxide and other harmful substances are released into the atmosphere, which leads to global warming, air pollution, and disruption of the ecological balance. Therefore, the development of sustainable transport systems is of great importance. Sustainable transport is a transport model that ensures economic development, causes minimal damage to the environment, and is accessible to society. These systems include the expansion of public transport, the introduction of electric vehicles, the creation of bicycle and pedestrian infrastructure, the use of smart transport technologies, and the application of alternative energy sources. Important steps are being taken in Azerbaijan to modernize the transport system. The expansion of metro lines in Baku, the use of electric buses, the construction of bicycle lanes, and the implementation of smart city projects create important prospects in this area. Sustainable transport systems serve to reduce air pollution, increase energy efficiency, enhance urban mobility, and improve the quality of life of people. Consequently, the development of environmentally friendly and innovative transportation models will make a significant contribution to the formation of a healthier, safer, and more livable society in the future.

Keywords: Climate change; sustainable transport; carbon emissions; eco-friendly technologies; urban mobility

1. INTRODUCTION

In modern times, climate change is considered one of the most serious and urgent global problems facing the countries of the world. In recent years, as a result of the increase in greenhouse gases, especially carbon dioxide and methane emissions, the average temperature on Earth has risen, the global warming process is accelerating, and the number of extreme weather events such as air pollution, droughts, floods, forest fires, and strong storms is increasing (United Nations Environment Programme, 2023). These changes have a serious negative impact not only on nature, but also on the economy, human health, agriculture, and urban infrastructure.

One of the main areas affecting climate change is the transport sector. As a result of increasing urbanization, population growth, and increased mobility, demand for automobile, air, sea, and rail transportation is rapidly growing. In particular, vehicles running on gasoline and diesel fuel emit large amounts of carbon dioxide and other harmful emissions, causing atmospheric pollution. The increase in the number of cars in cities leads to increased traffic congestion, higher fuel consumption, increased noise, and a decrease in the quality of life of people. That is why the development of sustainable transportation systems is considered one of the important directions of the modern era. The implementation of environmentally friendly, energy-efficient, and accessible transport solutions creates conditions for both reducing emissions and creating a healthier and more comfortable living environment in cities. Electric vehicles, strengthened public transport, bicycle and pedestrian infrastructure, and smart transport technologies are considered important tools in the fight against climate change. Therefore, the development of sustainable transport systems is of particular importance both in terms of ensuring environmental security and building a more livable world for future generations.

2. THE SUSTAINABLE TRANSPORT CONCEPT

A sustainable transport system is a modern transport model that supports economic development, causes minimal damage to the environment, and is accessible to all segments of society. This concept, in addition to ensuring the movement of people and goods, also implies the efficient use of natural resources, energy conservation, and protection of ecological balance. Sustainable transport systems are based on the principle of long-term development, not only meeting today's demand but also taking into account the needs of future generations (International Energy Agency, 2022). These systems are grounded in energy efficiency, the use of alternative fuels, the development of public transport, and the application of environmentally friendly technologies.

Electric vehicles, hybrid vehicles, and solar and hydrogen-powered transport solutions are considered important innovations in this area. The development of public transport such as metro, bus, tram, and railway creates conditions for reducing dependence on private cars and minimizing carbon emissions. The concept of sustainable transport is also closely related to urban planning and social well-being. The construction of bicycle paths, the creation of pedestrian zones, safe road infrastructure, and digital management systems increase the comfortable and safe movement of people. This approach has a positive impact on reducing traffic congestion in cities, improving air quality, and raising the standard of living of citizens. In general, the main goal of a sustainable transport system is to ensure the safe, comfortable, fast, and environmentally friendly transportation of people and goods, while maintaining economic efficiency and social equality. For this reason, sustainable transport is considered one of the important development directions for the cities of the future.

3. THE IMPACT OF THE TRANSPORT SECTOR ON CLIMATE CHANGE

The transport sector is considered one of the main sources of carbon emissions in the world and plays an important role in accelerating climate change. Along with industry, energy, and agriculture, the transport sector also contributes to global warming by emitting large amounts of greenhouse gases into the atmosphere. Especially in recent years, population growth, urbanization, and the increasing need for mobility have led to a rapid increase in the number of vehicles, which has resulted in higher fuel consumption and deepening environmental problems. In particular, gasoline and diesel-powered vehicles emit carbon dioxide, nitrogen oxides, sulfur compounds, and other harmful substances into the air. These emissions increase the amount of heat-trapping gases in the atmosphere and cause

climate change (World Health Organization, 2021). At the same time, they reduce air quality, lead to the formation of acid rain, and disrupt the ecological balance in urban environments.

In addition to road transport, air transport, maritime transport, and heavy freight vehicles also have a serious impact on the environment as high fuel consumption sectors (United Nations Environment Programme, 2023). The increase in the number of cars in cities leads to the formation of traffic congestion, weakening of traffic flow, and increased time loss. Long-term idling of engines during traffic congestion leads to higher fuel consumption and additional emissions. Furthermore, noise pollution negatively affects people's psychological state, increases stress levels, and reduces the comfort of city life. These processes have a serious negative impact on both human health and the climate system (Intergovernmental Panel on Climate Change, 2021). Polluted air leads to an increase in respiratory diseases, cardiovascular problems, and allergic diseases. On the other hand, the increase in greenhouse gases in the atmosphere leads to rising temperatures, melting glaciers, rising sea levels, and an increase in extreme weather events. Therefore, reducing emissions in the transport sector, introducing environmentally friendly technologies, and developing sustainable transport systems are considered one of the main priorities of global climate policy.

4. SUSTAINABLE TRANSPORTATION SOLUTIONS

The implementation of sustainable transport solutions is of particular importance in the fight against climate change. The expansion of environmentally friendly, energy-efficient, and modern approaches in the transport sector helps to reduce harmful gases emitted into the atmosphere, improve air quality in cities, and increase the comfort of people's lives. In this regard, a number of principal sustainable transport solutions come to the fore.

4.1 Development of Public Transport

The expansion of metro, bus, tram, and train systems has a significant impact on reducing the use of private cars. High-quality and accessible public transport facilitates the daily movement of citizens, reduces traffic congestion, and minimizes fuel consumption. In particular, fast and comfortable public transport networks support the solution of environmental problems by increasing mobility in cities. Mass transit systems can reduce per-passenger carbon emissions by a factor of four to five compared to single-occupancy private vehicles (Organisation for Economic Co-operation and Development, 2021).

4.2 Electric Vehicles

Electric vehicles produce fewer emissions and reduce air pollution compared to traditional gasoline and diesel vehicles. These vehicles are considered more energy efficient and reduce noise levels within cities (Zülfüqarova, 2024). Expanding charging infrastructure and government incentives can accelerate the spread of electric vehicles. According to the International Energy Agency (2022), investment in electric vehicle charging networks and purchase subsidies has been among the most effective policy tools for decarbonizing urban transport.

4.3 Bicycle and Pedestrian Infrastructure

Building bicycle paths, creating pedestrian zones, and organizing safe crossings increase the possibilities for environmentally friendly movement. Promoting cycling and walking instead of car use for short distances reduces carbon emissions significantly. At the same time, this approach has a positive effect on people's physical health, supports an active lifestyle, and helps to form more comfortable public spaces in cities. Research by Litman (2019) confirms that investments in walking

and cycling infrastructure yield among the highest returns in terms of emissions reductions per unit of expenditure.

4.4 Intelligent Transport Systems

Transport management through digital technologies plays an important role in modern cities. Intelligent traffic light systems, real-time information platforms, route planning programs, and automatic regulation of traffic flow create conditions for reducing traffic congestion. As a result, fuel consumption is reduced, time loss is minimized, and the transport system operates more efficiently. The International Transport Forum (2020) identifies smart mobility systems as essential infrastructure for achieving net-zero transport emissions targets.

4.5 Alternative Energy Sources

Hydrogen, biofuel, and solar-powered vehicles are considered promising solutions for the future. These technologies reduce dependence on traditional fossil fuels and serve to strengthen environmental safety. Vehicles powered by hydrogen fuel cells are considered an important alternative for long-distance transportation, while the use of solar energy accelerates the integration of renewable energy resources into transport (International Renewable Energy Agency, 2022). The implementation of these sustainable transport solutions is therefore one of the most important directions in the fight against climate change, enabling both a reduction in carbon emissions and an improvement in the ecological situation in cities.

5. PROSPECTS FOR AZERBAIJAN

Important steps have been taken in recent years to modernize the transport system in Azerbaijan and bring it into line with international standards. The acceleration of economic development, the increase in urbanization, and the growing demand for mobility have necessitated the renewal of transport infrastructure. In this regard, the establishment of sustainable transport systems is of particular significance in terms of both economic efficiency and environmental safety.

The expansion of metro lines in Baku is one of the most important projects in this area. The construction of new stations and the renewal of existing lines create conditions for more convenient passenger transportation, reduce traffic congestion, and minimize the use of private cars. The metro system plays an important role in urban mobility as both a fast and environmentally more efficient means of transport. In addition, the introduction of electric buses and the renewal of the public transport fleet serve to reduce harmful gases emitted into the atmosphere (Ritchie, 2020). The use of modern and comfortable buses increases passenger satisfaction, makes movement within the city more accessible, and contributes to the development of environmentally friendly transport. The creation of bicycle lanes and the expansion of pedestrian infrastructure are also important aspects of sustainable transport policy. The use of bicycles, especially for short distances in city centers, has a positive effect on both reducing traffic congestion and promoting a healthy lifestyle.

The introduction of digital management systems within the framework of smart city projects also opens up new prospects in the field of transport in Azerbaijan. Smart traffic lights, electronic payment systems, real-time route information, and digital management of traffic flow allow for more efficient organization of movement within the city, leading to a reduction in time loss and fuel consumption. In general, these measures simultaneously increase urban mobility and serve to improve the ecological situation. The development of sustainable transport systems in Azerbaijan will make a significant contribution to the formation of a more comfortable, safe, and livable urban environment in the future, consistent with the country’s commitments under the Paris Agreement and the 2030 Sustainable Development Goals (United Nations, 2019; World Bank, 2021).

6. CONCLUSION

Sustainable transport systems are considered one of the most important and strategic tools in the fight against climate change. In modern times, the increase in carbon emissions released into the atmosphere by the transport sector is one of the main factors accelerating global warming. Therefore, the application of environmentally friendly and efficient solutions in the field of transport is of great importance not only in terms of improving urban transport, but also in terms of preserving the ecological balance of the planet.

The development of this area is necessary to reduce negative impacts on the environment, minimize air pollution, increase energy efficiency, and ensure the rational use of natural resources. The spread of electric vehicles, the strengthening of public transport, the expansion of bicycle and pedestrian infrastructure, and the application of smart transport technologies collectively help solve both environmental and social problems in cities. These approaches create conditions for reducing traffic congestion, minimizing fuel consumption, and allowing people to move more comfortably. The development of sustainable transport systems also has a significant impact on improving the quality of life in cities. Cleaner air, reduced noise, safe roads, and comfortable public transport have a positive effect on people's health and daily lives (Zülfüqarova, 2024). At the same time, investments in this area lead to the creation of new jobs, the development of innovations, and an increase in economic competitiveness.

In the future, the introduction of environmentally friendly and innovative transport models will make a significant contribution to the formation of a healthier, safer, and more sustainable society. As a result of joint cooperation between the state, the private sector, and society, it will be possible to successfully implement a green transport policy. Thus, sustainable transport systems are not only a solution to today's problems, but also one of the main directions of building a more livable world for future generations.

DECLARATIONS

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ABOUT THE AUTHORS

Tunzala Alifova is a lecturer at Mingachevir State University, Azerbaijan. Her research interests include sustainable transport, climate change policy, and urban mobility.

https://orcid.org/0009-0007-7962-6717

Email: tunzala.alifova.h@mdu.edu.az

Jeyhuna Allahverdiyeva is an operator at Mingachevir State University, Azerbaijan. Her research interests include environmental economics, sustainable development, and green transport systems.

https://orcid.org/0009-0000-5034-9348

Email: ceyhuna.allahverdiyeva@mdu.edu.az

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