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PATHWAYS TO PROSPERITY AND SUSTAINABILITY: ASSESSING THE EFFECTS OF TRANSPORT INFRASTRUCTURE INVESTMENTS ON ECONOMIC GROWTH AND GHG EMISSIONS IN AZERBAIJAN IN THE CONTEXT OF COP 29

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Abstract: *Ahead of Azerbaijan's hosting of COP 29, this paper examines the impacts of transport infrastructure investments in Azerbaijan on economic growth and greenhouse gas (GHG) emissions. In this study, using the data of the official reports of the Statistical Committee of the Republic of Azerbaijan and the World Bank, the Ordinary Least Squares (OLS) regression analysis tool was used to reveal the potential impact of investments in transportation infrastructure. The main essence of this study is to examine the strategic investment projects aimed at modernizing the transportation networks of Azerbaijan and its ambitious effects. The nation's vision is not limited to infrastructural development, but also strives to achieve sustainable progress by establishing itself as a global leader in promoting environmentally conscious activities. Through political certainty and international cooperation, Azerbaijan is trying to show itself as a leader in promoting sustainable development in the context of 29th Conference of the Parties (COP 29). The research aims to examine how the planned development of transport infrastructure drives economic progress with a focus on climate impacts. This article revealed the significant role of investments in transport infrastructure in fostering economic growth in Azerbaijan, particularly through positive effects on the non-oil GDP growth rate. However, it found that these investments did not lead to substantial reductions in GHG emissions, indicating a lack of corresponding environmental benefits. This underscores the complex interplay between infrastructure development and environmental sustainability, highlighting the necessity for a balanced approach in policy implementation.*

Keywords: *COP29, Economic growth, Greenhouse gas (GHG), Transport infrastructure investments, Azerbaijan.*

Introduction

In the dynamic economic landscape of Azerbaijan, transport infrastructure is emerging as a major force ready to drive both economic growth and sustainability. Azerbaijan's importance as a strategic hub on the historic Silk Road holds great promise for its targeted investment in transportation networks to accelerate economic growth. However, these positive promises are not without drawbacks, as the mentioned activities highlight the challenge of limiting GHG emissions in particular. This article examines the delicate balance between increasing economic growth through the expansion of transport infrastructure and the urgent

need to protect the ecology. At the heart of this story is the government's strong commitment to developing the transport sector. By strengthening trade ties within and outside the country, Azerbaijan aims to facilitate unhindered trade flows, promote regional integration, and move its economy away from heavy dependence on oil revenues. The heritage of the Silk Road combined with modern aspirations plays a very critical role in the economic and political life of Azerbaijan for trade and cultural exchange. However, the vision requires a dual focus—one that scrutinizes the economic gains while acknowledging the environmental costs. From highways to railroads, from ports to airports, the growth in transportation infrastructure projects has undeniable economic implications. This boosts job creation, stimulates investment and increases trade opportunities. However, these activities also have negative downsides: increased emissions, habitat destruction, and resource depletion and etc. The difficulty lies in harmonizing these seemingly different directions. Azerbaijan's commitment to environmental protection is obvious. The declaration of 2024 as the "Year of Green World Solidarity" underlines its determination. Besides, by signing the Paris Agreement, Azerbaijan undertook to reduce emissions by 2030 and 2050. This alignment with global climate goals requires serious consideration of the GHG impact of transportation infrastructure. Can economic growth go hand in hand with carbon reduction? Policy coherence, technological innovation and sustainable practices can answer this question. This article explores Azerbaijan's strategic investments in transport sector. As Azerbaijan prepares to host COP 29, it seeks to strengthen its role as a champion of sustainable development. The focus should be on how transport infrastructure can be a conduit for economic growth while minimizing environmental damage. The road ahead is both pragmatic and aspirational.

Main objective

The main purpose of this article is to comprehensively examine the impact of investments in transport infrastructure on both economic growth and GHG emissions in Azerbaijan. This analysis is carried out on the eve of the COP 29. The study seeks to strike a balance between promoting economic growth through transport infrastructure development and addressing the critical imperative of environmental sustainability. Specifically, the study focuses on the following key directions:

Economic Impact

How did investments in transport infrastructure affect the economic growth of Azerbaijan?

Environmental Impact

What are the environmental consequences of these investments, especially in terms of greenhouse gas emissions?

This article aims to provide a final comprehensive conclusion based on factual data to assess the advantages and disadvantages of significant investments in the sector. The main goal is to provide valuable ideas and results that can advise on future options regarding the development of transport infrastructure, focusing on activities in the direction of increasing economic growth and environmental protection in Azerbaijan.

Literature review

Investments in transportation infrastructure have consistently demonstrated a positive relationship with economic prosperity in various economies. Transport infrastructure development plays an important role in increasing productivity, connectivity and overall economic growth. According to Banister and Berechman robust transport networks contribute significantly to regional development by promoting the efficient movement of goods and people. (Banister & Berechman, 2000). In the context of developing economies, infrastructure plays a key role in supporting economic expansion and diversification. (Rodrigue, 2016). Focusing on transport as one of the main directions of the non-oil sector in Azerbaijan is in line with the country's goals to reduce oil dependence and promote economic stability, especially after 2000. (Asian Development Bank, 2019)

The economic benefits of investments in transportation infrastructure are well documented, and numerous studies have found that these investments have a positive impact on GDP growth, job creation, and trade efficiency. (Aschauer, 1989; Calderón & Servén, 2004). In the context of Azerbaijan, investments in the transport sector have played a key role in the diversification of the economy, and the sector's potential as a catalyst for growth is highlighted. (Asian Development Bank, 2019).

Annual Review of Environment and Resources provides an overview of how transport infrastructure can both reduce and exacerbate environmental degradation, including GHG emissions. (Doll & Puppim de Oliveira, J. A., 2017).

EBRD conducted a sustainability assessment of Azerbaijan's transport sector with a special focus on efforts to reduce carbon emissions. (European Bank for Reconstruction and Development (EBRD),2019).

"Towards Sustainable Transport in Azerbaijan" report details the strategies of Azerbaijan for implementing sustainable transportation solutions aimed at reducing GHG emissions, consistent with its national objectives and global obligations. (United Nations Development Programme (UNDP), 2021).

Although the economic benefit of transport infrastructure is clear, the environmental consequences, especially GHG emissions, require detailed investigation. The transport sector is a major contributor to global carbon emissions, and infrastructure development often results in increased fossil fuel use. (Sims et al., 2014). The development of road infrastructure and the increase in the ownership of vehicles in Azerbaijan have created problems for both national and international sustainability goals and led to an increase in GHG emissions. (European Environment Agency, 2020). The importance of considering environmental factors in planning infrastructure investments is emphasized in global commitments to reduce emissions and combat climate change. (UNFCCC, 2021).

Azerbaijan's way of adapting economic progress to environmental sustainability reflects a broader global problem. While a country's infrastructure investments are critical to economic growth, considering their environmental impacts is complicated. Approaches to reduce these impacts include using greener technologies, increasing energy efficiency, and investing in public transportation systems. (World Bank, 2019). In addition, Azerbaijan's participation in global environmental agreements underscores its commitment to synchronizing infrastructure development with sustainability goals (World Bank, 2019). In addition,

Azerbaijan's participation in international environmental agreements emphasizes its commitment to aligning infrastructure development with sustainability goals. (IEA, 2019).

Methodology

In this research, the quantitative methods were used to assess the impact of transport infrastructure investments in Azerbaijan on both economic growth and GHG emissions. In order to exclude oil effect, non-oil GDP growth rate we used as economic growth indicator, in order better gauge the impact of investments. The data used in this study, the figures for investments in transport infrastructure and the growth rate of non-oil GDP were taken from the Statistical Committee of the Republic of Azerbaijan, and the data on greenhouse gas emissions were taken from the official reports of the World Bank. The data for the period covering the years 2010-2020 were used in the analysis.

The Ordinary Least Squares (OLS) regression models were used to examine the effects of transport infrastructure investments on economic growth and the environment. These models allowed to measure how increased spending on transport infrastructure could affect economic growth and environmental outcomes in Azerbaijan. Specifically, two separate regression models developed:

GDP Growth Model: This model predicted non-oil GDP growth as a function of transport investments. By examining the direct relationship between investment volume and economic performance, we gained insights into the potential economic benefits of infrastructure spending.

GHG Emissions Model: The second model focused on greenhouse gas emissions, using volumes with the same investment as the first model. This allowed us to assess the impact of transport development on the environment.

In evaluating the models' adequacy, we considered the R-squared value—a measure of how much variance in the dependent variable (non-oil GDP growth or GHG emissions) could be explained by the independent variable (transport investments). In addition, p-values helped determine the statistical significance of our findings.

This methodology not only emphasized the positive effects of increased infrastructure spending on economic growth, but also considered environmental issues in line with global sustainability goals. By understanding the economic growth and environmental impacts of investments in the sector, public administrators can make informed decisions about their investments in transportation infrastructure in Azerbaijan.

Limitation of methodology

A major drawback of this approach is that it relies on linear ordinary least squares (OLS) regression. This method assumes a direct and invariant relationship between variables, which can oversimplify complex economic and environmental dynamics. Furthermore, the analysis is limited by the use of annual data, potentially missing short-term fluctuations and lagged effects of investment on non-oil GDP and GHG emissions. In addition, the study only focuses on transport investments and does not consider other influencing factors such as policy changes, technological advances, economic and legal issues. Finally, the small sample size hinders the generalizability and statistical robustness of the findings.

Conference of the Parties (COP) and Its Implications

The Conference of the Parties (COP) is the highest decision-making body of the United Nations Framework Convention on Climate Change (UNFCCC), established in 1994. This includes all 197 states that have ratified the Convention. The COP is held annually to assess progress in addressing climate change, negotiate additional measures and review the implementation of the Convention along with the Kyoto Protocol and the Paris Agreement.

COP 29, scheduled to be held in Baku in November 2024, is a continuation of global efforts to combat climate change. After 2023, the warmest year on record, the conference will focus on key areas such as understanding global emissions and finalizing the first enhanced transparency framework essential to progress towards climate goals. In addition, it will seek to establish a new collective clear target for climate finance, stating the need for increased financial support to scale up climate action.

Each COP serves as an important platform for negotiating and advancing global climate action, and COP 29 will be no exception, with high stakes for both policy and practical implementation strategies to combat climate change. An important stage in Azerbaijan's green initiatives is to fulfill its role as the host country of the COP29 UN Climate Change Conference, which will be held in Baku at the end of this year. This event is considered an important opportunity for Azerbaijan to demonstrate its progress in the field of green energy and strengthen international cooperation on climate action.

Transport infrastructure in Azerbaijan: an overview

The transport sector of Azerbaijan has a deep historical history, through which the ancient Silk Road passes. This historic trade route facilitated the exchange of goods, cultures and ideas between East and West. Over the centuries, the geographical position of Azerbaijan has maintained its relevance as a major trade center. Strategically located at the crossroads of north-south and east-west trade routes between Asia, the Middle East and Europe, Azerbaijan is currently an important producer and exporter of oil and gas in the Caspian Sea region. The transport sector in Azerbaijan is developing rapidly and makes a significant contribution to the country's Gross Domestic Product (GDP). However, the sector faces a number of challenges, such as a lack of coordination between government priorities and activities of key stakeholders, and a lack of data on transport sector emissions.

Especially considering its strategic location at the intersection of Eastern Europe and Western Asia, transport infrastructure has been the main focus of Azerbaijan's development strategy. The government is focusing on improving and expanding transport networks to facilitate economic growth, strengthen connectivity and integrate more effectively into global trade systems. The transport infrastructure of Azerbaijan consists of railway transport, road transport, sea transport and air transport:

Road Network

The primary entity for roads in Azerbaijan is the State Agency of Azerbaijan Automotive Roads (AAYDA), established in 2017. AAYDA is responsible for the design, construction, operation, repair, and maintenance of state highways and other road facilities. Azerbaijan has made significant investments in road infrastructure to improve connectivity and

transport efficiency within and outside the country. The government has implemented numerous road construction and rehabilitation projects to expand the road network, reduce travel times and improve road safety. North-South and East-West highways are vital arteries that connect different regions of Azerbaijan and promote trade within the country. The development of highways and expressways has not only facilitated the movement of goods and people, but also strengthened regional integration and economic activities. Effective road connectivity has given businesses easier access to markets, thus spurring economic development in both urban and rural areas.

Rail System

Railway transport in Azerbaijan is managed by Azerbaijan Railways Closed Joint Stock Company (ADY), established in 2009. ADY provides both freight and passenger railway services in the country. Railway transport plays an important role in the transport sector of Azerbaijan, especially in facilitating trade between Europe and Asia. The Baku-Tbilisi-Kars (BTQ) railway project, which was completed in 2017, is of great importance in this regard. BTK railway connects Baku, the capital of Azerbaijan, with Tbilisi, the capital of Georgia, and then with the port city of Kars, Turkey. This strategic rail corridor provides a shorter and more efficient route for transporting goods between Europe and Asia, bypassing congested Black Sea ports. By reducing transportation costs and transit times, the BTQ railway has turned Azerbaijan into an important transit country, attracting significant trade volumes and foreign investments. In addition, Azerbaijan's railway network connects different regions of the country, contributes to regional economic development and strengthens social cohesion.

Air transport

Air transport in Azerbaijan is managed by Azerbaijan Airlines (AZAL). Baku’s Heydar Aliyev International Airport, the primary international gateway into Azerbaijan, has seen extensive upgrades to its facilities and services, aligning with international standards. The expansion of air services is supported by improvements at other major airports in the country, including Nakhchivan and Ganja, which are crucial for boosting tourism and business travel. The development of Azerbaijan's air transport infrastructure has contributed to economic development, especially to the tourism sector. Heydar Aliyev International Airport in Baku, along with other regional airports, has played an important role in promoting tourism by facilitating accessibility for international travelers. Azerbaijan's rich cultural heritage, diverse landscapes and modern attractions have increased the number of tourists in recent years. The availability of well-coordinated airlines and international flights has been an important factor in boosting the country's tourism industry, thereby stimulating economic growth in related sectors such as hospitality, retail and services.

Sea and Ports

The State Maritime Agency is the regulatory body in charge of maritime transport in Azerbaijan. The Port of Baku at Alat has been transformed into a major logistics and trade hub. Azerbaijan's access to the Caspian Sea has been an important factor in the development of its maritime transport sector. The country has invested in port facilities, infrastructure and logistics to increase its capacity to handle cargo and promote maritime trade. Baku Port, located in a strategic position on the coast of the Caspian Sea, has become a decisive center for international trade, especially for landlocked Central Asian countries. The establishment of the International

North-South Transport Corridor has further increased the importance of Azerbaijan as a transit country. The corridor is a multimodal transport corridor connecting India, Iran, Azerbaijan and Russia, providing an alternative trade route between South Asia and Europe. This initiative expanded the role of Azerbaijan as a transit country and offered profitable opportunities for economic growth and attracting foreign investments.

Urban Transport

In urban areas, especially in Baku, the government is focusing on modernizing public transport to reduce traffic congestion and pollution. This includes the expansion of the Baku Metro and the introduction of bus rapid transit systems. Investments in these areas are aimed at improving the quality of life of residents and supporting sustainable urban development.

Revitalization in Liberated Territories and Zangazur Corridor Initiative

Azerbaijan aggressively continues to build new transport links and restore old ones in the liberated territories. These efforts aim to support economic development and strengthen connectivity in these regions. The Zangezur Corridor is an important initiative aimed at creating a direct transport link between Azerbaijan and its exclave, Nakhchivan. This corridor is expected to simplify transit routes and strengthen economic ties throughout the region. This is an important step towards strengthening regional integration and connectivity.

Government Initiatives for Sustainable Transportation

Azerbaijan has achieved many in the field of improvement of environmental standards and promotion of green transport. The government promotes the use of EU-95 gasoline, which emits less carbon dioxide, by adopting Euro 5 standards, and has imposed restrictions on the import of old cars for more than seven years. The State Customs Committee has banned the import of vehicles manufactured before 2013, thereby renewing the country's vehicle fleet, which strengthens both environmental protection and road safety.

In addition, local production of EU-95 brand gasoline has been started in order to reduce fuel costs and minimize the impact of transportation on the environment within the framework of the measures. This initiative aims to phase out old types of gasoline and support Azerbaijan's transition to sustainable fuel use. In addition, the government has introduced fiscal incentives to encourage the use of electric and hybrid vehicles. For example, until 2025, newly imported electric cars, CNG buses and related equipment are exempted from VAT.

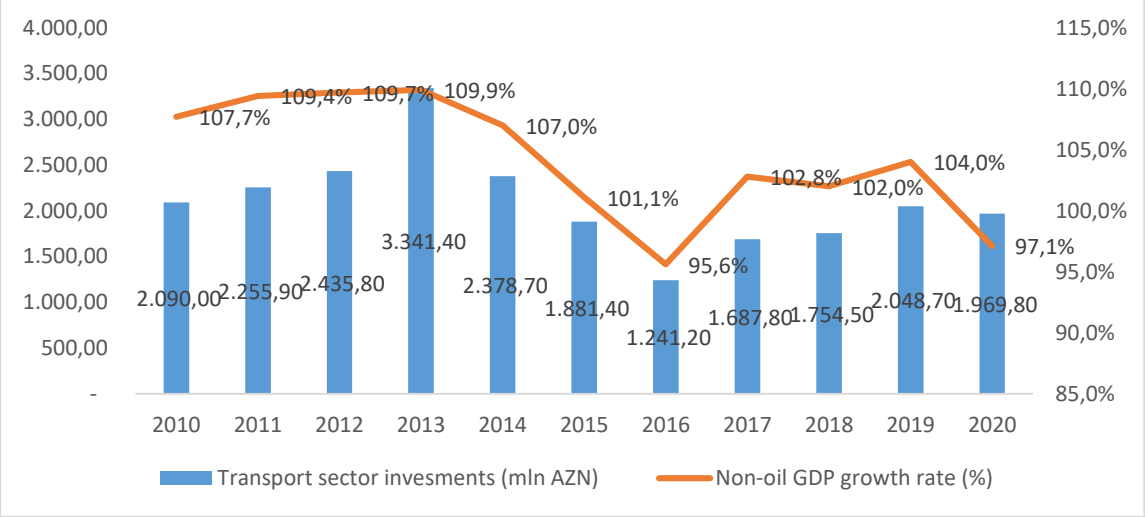
In order to strengthen public transport in Azerbaijan, large amounts of subsidies are allocated for public transport, and public-private partnership is promoted. At the same time, new bus and subway lines are being built, and work is being continued on suburban and inter-regional high-speed railways. In line with green city initiatives, the development of bicycle and pedestrian infrastructure and bicycle and car sharing schemes further support sustainable urban mobility. In the freight sector, which accounts for a large share of the country's greenhouse gas emissions, the government is working through legislative measures and campaigns to modernize the truck fleet and support clean and energy-efficient transportation. Railway transport is also doing a lot to protect the environment by electrifying lines, using renewable energy sources and implementing energy-saving technologies, replacing diesel locomotives and trains with electric locomotives and trains. This also includes the installation of solar panels

and wind turbines on electric railway infrastructure. These comprehensive actions demonstrate Azerbaijan's commitment to reducing emissions, modernizing transport systems and promoting sustainable development. This coincides with the efforts of the government to adapt its activities in the direction of economic growth to environmental sustainability.

OLS Regression Analysis: Assessing Transport Investments' Influence on Azerbaijan's Economic Growth and Environmental Sustainability

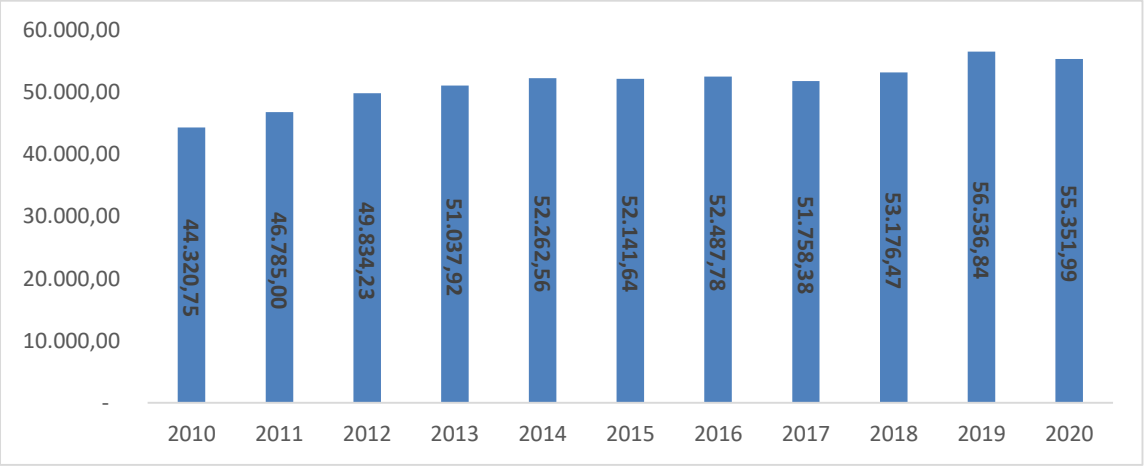
The data of the Statistical Committee of the Republic of Azerbaijan and the World Bank covering the decade from 2010 to 2020 were used in the analysis. The main objective of the analysis is to reveal potential causal relationships that provide insights into both economic and environmental aspects of investments in the transport sector by applying Ordinary Least Squares (OLS) regression analysis. This methodological approach allows for a comprehensive understanding of the interaction between the development of transport infrastructure and its impact on economic growth and greenhouse gas emissions.

Chart 1. ***Transport infrastructure investments and economic growth***



Source: The State Statistical Committee of the Republic of Azerbaijan

Chart 2. ***Total greenhouse gas emissions (kt of CO2 equivalent)***



Source: World Bank

Model Descriptions

Two distinct OLS regression models were developed to assess:

Economic Impact: How transport infrastructure investments influence GDP growth, highlighting potential pathways to prosperity.

$$\text{GDP Growth} = \beta 0 + \beta 1 \times \text{Transport Investments} + \epsilon$$

Environmental Impact: The effect of these investments on GHG emissions, which is critical for evaluating sustainability in the context of global climate commitments.

$$\text{GHG Emissions} = \alpha_0 + \alpha_1 \times \text{Transport Investments} + \mu$$

Table 1: Impact of Transport Infrastructure Investments on non-oil GDP Growth

Variable	Coefficient	Std. Error	t-statistic	P-value	95% Confidence Interval
Constant	88.8825	4.236	20.984	0.000	[79.301, 98.464]
Transport Investments	0.0073	0.002	3.723	0.005	[0.003, 0.012]

R-squared: 0.606

Adjusted R-squared: 0.563

Table 1 reveals a substantial positive correlation between transport infrastructure investments and non-oil GDP growth. For every unit increase in transport investments, there is a 0.0073 unit increase in non-oil GDP, as shown by a statistically significant coefficient (p-value = 0.005). The model accounts for 60.6% of the variation in non-oil GDP growth (R-squared), suggesting a robust fit. When adjusted for the number of predictors, the Adjusted R-squared is 56.3%, further confirming the model's efficacy. These results highlight the critical role of transport investments in driving economic growth, offering valuable insights for policy formulation.

Table 2: Relationship Between Transport Infrastructure Investments and GHG Emissions

Variable	Coefficient	Std. Error	t-statistic	P-value	95% Confidence Interval
Constant	54390	4594.077	11.838	0.000	[44000, 64800]
Transport Investments	-1.4101	2.127	-0.663	0.524	[-6.223, 3.402]

R-squared: 0.047

Adjusted R-squared: -0.059

Table 2 investigates the association between transport infrastructure investments and GHG)emissions, showing an insignificant relationship. The model indicates a decrease in GHG emissions by 1.4101 units for each unit increase in transport investments, but this effect is statistically not significant (p-value = 0.524), and the confidence interval encompasses zero.

The R-squared of the model is 4.7%, suggesting it only accounts for a minor fraction of the variance in GHG emissions. Moreover, the negative Adjusted R-squared of -0.059 implies that the model may be less predictive than a simple mean. These results suggest that other factors may have a more significant impact on GHG emissions, emphasizing the necessity for a broader analysis.

Discussions

The objectives of the research were successfully achieved through a comprehensive analysis of the impact of transport infrastructure investments on both economic growth GHG emissions in Azerbaijan. The study aimed to fill a research gap by addressing two main research questions:

Economic Impact: The analysis confirmed that investments in transport infrastructure significantly boosted economic growth in Azerbaijan. This finding aligns with the insights provided in the initial part of the article, which highlighted how infrastructure development enhances trade flows, stimulates investment, and diversifies the economy away from oil dependence.

Environmental Impact: On the other hand, the study revealed that while there were notable economic benefits, the reduction in GHG emissions as a result of these investments was statistically insignificant.

The analysis identified the important role of investments in transport infrastructure in promoting economic growth in Azerbaijan and demonstrated its positive effects on non-oil GDP growth rate. However, the relationship between these investments and reductions in GHG emissions was found to be statistically insignificant, indicating that these economic gains did not translate into corresponding environmental improvements. This highlights the complex interdependence between infrastructure development and environmental sustainability, emphasizing the need for a balanced approach when implementing policies in this direction.

The results of OLS regression models show that although investments in transport infrastructure are crucial factors for economic growth, their environmental impact is less and additional measures are necessary in accordance with Azerbaijan's sustainability goals. This study highlights the importance of considering both economic and environmental factors in the planning and implementation of transport infrastructure projects.

Based on the research results and findings, the following recommendations are offered to guide the development of future transport infrastructure projects in Azerbaijan:

Policy Integration: Formulate integrated policies that aim for environmental sustainability alongside economic growth. This may include environmental impact assessment and amendments to existing infrastructure policies to take into account sustainability standards.

Investment in Green Technologies: Expand investments in green transport technologies such as electric buses, sustainable urban transport systems and renewable energy sources for infrastructure. These technologies can help reduce the carbon footprints associated with new and existing transportation networks. Public-Private Partnerships (PPPs): Promoting the creation of PPPs to increase private sector participation in investments in the sector to create sustainable transport solutions. These partnerships can also ensure the sharing of risks and benefits associated with large-scale infrastructure projects.

Educational and Public Awareness Programs: Initiate educational programs and public awareness campaigns on the benefits of sustainable transport solutions to reach a wider audience. These programs can enhance public acceptance and use of new systems, thereby maximizing their environmental and economic benefits.

Regulatory Frameworks: Improve regulatory frameworks to ensure that all new transport infrastructure projects meet environmental standards and contribute to national and international sustainability goals. These frameworks may include setting strict emission standards and green certification for new projects.

By implementing these recommendations, Azerbaijan can ensure that investments in transport infrastructure contribute positively to both economic growth and environmental health, thereby supporting the country's broader sustainable development goals. These events will also strengthen Azerbaijan's commitment to global climate initiatives and its role as host of the upcoming COP 29.

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