DOI: https://doi.org/10.31410/ITEMA.2024.287

Innovative Comparative Approaches to Transport and Transport Infrastructure Between Romania and Other European Union Countries

Paul V. Zai[1]
Cristiana Moraru[2]

Received: October 9, 2024
Accepted: February 28, 2025
Published: June 2, 2025

Keywords:
Transport infrastructure;
Romania;
European Union (EU);
Sustainable mobility;
Innovative transport solutions

Abstract: *Transport infrastructure plays a critical role in economic growth, trade facilitation, and improving the overall quality of life. This paper provides a detailed comparative analysis of Romania's transport infrastructure relative to other European Union (EU) countries, with a focus on road, rail, maritime, and air transport systems. It explores the challenges Romania faces in modernizing its infrastructure, examines current policies, and offers innovative solutions that are critical for the country's progress. Additionally, the paper underscores the importance of sustainability, particularly the need to reduce carbon emissions and align with the EU's environmental goals. Through the integration of various data sources and policy recommendations, this paper suggests how Romania can enhance its transport infrastructure to improve connectivity, competitiveness, and economic growth. Sustainable transport solutions and innovative technologies are critical for Romania as it strives to close the gap with other EU countries and better integrate into the broader European market.*

1. INTRODUCTION

Transport infrastructure is a cornerstone of economic and social development, serving as the backbone for the mobility of people and goods. A well-functioning transport system promotes economic growth by facilitating trade, enhancing accessibility to markets, boosting tourism, and contributing to regional development. In today's globalized world, efficient transportation is not merely a domestic priority but a key factor in a country's competitiveness on the international stage. The quality and efficiency of transport systems directly influence the cost of goods and services, the attractiveness of a country for foreign direct investment, and its overall economic dynamism. Additionally, transport infrastructure plays a critical role in achieving societal goals such as social inclusion by ensuring that remote and disadvantaged regions remain connected to national and international markets.

The European Union (EU) recognizes the critical importance of transport infrastructure in its economic integration agenda. As one of the core components of the EU's single market, the seamless and sustainable movement of people and goods across member states underpins the functioning of the entire EU economy. The EU has prioritized the development of a cohesive and resilient transport network through initiatives like the Trans-European Transport Network (TEN-T) policy. The aim is to close the infrastructure gap among member states, particularly in Eastern Europe, to promote connectivity and ensure the smooth flow of commerce. However, despite these overarching efforts, disparities persist across the region, particularly in countries such as Romania, which continues to face significant challenges in modernizing its transport infrastructure.

[1] Babeş-Bolyai University, Faculty of Political, Administrative and Communication Sciences, Department of Public Administration and Management, Cluj-Napoca, Romania
[2] Master Student, Babeş-Bolyai University, Faculty of Political, Administrative and Communication Sciences, Department of Public Administration and Management, Cluj-Napoca, Romania

Romania, the seventh-largest country in the EU by population, holds a strategic position in Europe as a bridge between Western Europe and the Black Sea region, and by extension, the Middle East and Asia. This geographic position should, in theory, provide Romania with a significant competitive advantage in international trade. However, Romania's transport infrastructure has lagged behind that of other EU countries, particularly Western European nations. This underdevelopment is a result of historical underinvestment, systemic governance inefficiencies, and regulatory challenges that have hampered progress. The inadequate state of Romania's transport infrastructure not only affects domestic mobility but also limits the country's potential to fully integrate into the EU's broader economic framework.

The road transport sector, which is the most common mode of transportation in Romania, suffers from poor road quality, limited highway networks, and high accident rates, which are the worst in the EU. Similarly, Romania's rail system, which holds potential as an energy-efficient alternative to road transport, is characterized by aging infrastructure, low-speed trains, and limited electrification. Maritime and inland waterway transport, despite Romania's advantageous position on the Danube River and its access to the Black Sea, remains underutilized due to infrastructural and environmental challenges. Although Romania's air transport sector has seen growth, it too faces sustainability challenges, particularly in meeting the EU's ambitious carbon reduction targets.

This paper will investigate the current state of Romania's transport infrastructure, compare it with other EU countries, and explore innovative and sustainable solutions to bridge the gap. By examining various transport modes—road, rail, maritime, and air—this analysis will highlight Romania's strengths and weaknesses in the sector while proposing strategies for improvement. The goal is to suggest ways in which Romania can modernize its transport infrastructure to foster economic growth, increase regional connectivity, and contribute to the EU's sustainability objectives.

2. THEORETICAL FRAMEWORK AND POLICY CONTEXT

Transport infrastructure is widely recognized as a critical driver of economic development, regional integration, and competitiveness. The efficient movement of goods, services, and people forms the backbone of any modern economy, directly influencing trade, productivity, and market accessibility. In the context of the European Union (EU), transport infrastructure plays an even more pivotal role, given the emphasis on creating a unified internal market where physical borders between member states are minimized. This interconnectedness is facilitated by robust infrastructure networks, which ensure that goods and people can move freely and efficiently across national boundaries, driving economic integration and cohesion among member states.

From a theoretical perspective, transport infrastructure is often seen through the lens of economic geography and regional development theories, which suggest that well-developed transport networks reduce transaction costs, enhance economies of scale, and increase the spatial competitiveness of regions. This is particularly important in the EU, where disparities in transport infrastructure can exacerbate regional inequalities, leaving some countries or regions less integrated into the single market. Countries with underdeveloped infrastructure, such as Romania, face higher transportation costs, slower mobility, and reduced competitiveness, which hinder their economic potential.

At the policy level, the EU has long recognized the need to address infrastructure disparities between member states. The Trans-European Transport Network (TEN-T) policy, launched by the European Commission, is designed to address these challenges by developing a comprehensive, cross-border infrastructure network that spans the entire EU. The TEN-T policy aims to remove bottlenecks, fill missing infrastructure links, and promote the use of environmentally friendly

transport modes. This initiative is particularly relevant for Romania, which stands to benefit significantly from increased connectivity to Western Europe and other key EU markets. However, while Romania is a major beneficiary of TEN-T funding, the country's infrastructure development has been slower than anticipated, partly due to governance and regulatory challenges.

One of the most critical policy shifts in recent years has been the introduction of the European Green Deal, which aims to make the EU climate-neutral by 2050. The Green Deal highlights the transport sector as a key area for emissions reductions, given that transportation accounts for approximately 25% of the EU's total greenhouse gas emissions (European Commission, 2020). In this context, sustainable transport infrastructure development is not just an economic necessity but also an environmental imperative.

The European Climate Law, which was adopted in 2021, legally enshrines the EU's goal of achieving climate neutrality by 2050 and includes binding targets for reducing greenhouse gas emissions by 55% by 2030 (compared to 1990 levels). This law has far-reaching implications for Romania's transport sector, as it requires the country to overhaul its infrastructure to meet these ambitious targets. Romania, like other member states, must submit detailed national plans outlining how it intends to reduce emissions in sectors such as transport, energy, and industry. Given the transport sector's significant share of emissions, Romania's infrastructure development must be aligned with the goals of decarbonization, including the promotion of electric and hydrogen-powered vehicles, increased use of public transport, and greater investment in rail infrastructure.

Furthermore, the EU's Sustainable and Smart Mobility Strategy, launched in 2020, complements the Green Deal by outlining a comprehensive roadmap for achieving a more sustainable, digitalized, and resilient transport system by 2050. The strategy includes goals such as increasing the use of rail for long-distance travel and freight, promoting urban mobility solutions, and developing intelligent transport systems (ITS). Romania faces the dual challenge of modernizing its transport infrastructure while also integrating the digital and sustainable innovations outlined in this strategy. While countries like Germany, the Netherlands, and France are leading the way in implementing smart mobility solutions, Romania must accelerate its adoption of these technologies to keep pace with the rest of the EU.

Romania's specific governance challenges are compounded by structural issues, such as underinvestment in transport infrastructure and a lack of strategic foresight in project planning and execution. For example, despite receiving substantial funding from the EU's Cohesion Fund and Connecting Europe Facility (CEF), which are aimed at reducing infrastructure gaps between member states, Romania has struggled to absorb and effectively utilize these funds due to its inefficient public administration and complex regulatory environment. The slow pace of project approval and implementation has further delayed the modernization of critical transport infrastructure, such as highways and rail networks.

3. METHODOLOGY

This paper employs a mixed-methods approach to analyze Romania's transport infrastructure in comparison with other EU countries. Secondary data from various sources such as Eurostat, the European Environment Agency (EEA), and Romanian government reports are utilized to assess the state of Romania's transport systems. Comparative analysis is conducted to identify the gaps between Romania and its EU counterparts, while qualitative document analysis provides insights into policy approaches and best practices.

The paper also incorporates innovative solutions to address these gaps. For instance, hydrogen-powered transport and smart transit systems are evaluated as potential game-changers for Romania, particularly in the rail and maritime sectors. Case studies from other EU member states serve as examples of best practices, offering valuable lessons for Romania's transport policies and infrastructure development.

4. COMPARATIVE ANALYSIS OF ROMANIAN TRANSPORT INFRASTRUCTURE

4.1. Road Transport

Romania's road transport sector is underdeveloped compared to other EU member states. Despite being the most common mode of transportation, Romania ranks 16th in the EU regarding highway length. The country has only 486 kilometers of highways per million inhabitants, a figure significantly lower than Hungary, which boasts 1936 kilometers per million. This lack of adequate road infrastructure contributes to significant traffic congestion, particularly in urban areas, and results in unsafe road conditions, especially in rural regions. The underdevelopment is also reflected in the country's road safety record.

Romania has the highest road accident fatality rate in the EU, with 93 deaths per 100,000 inhabitants in 2021, largely due to poorly maintained roads and reckless driving (Eurostat, 2023).

The situation is exacerbated by the fact that Romania relies heavily on road transport for freight and passenger movement, contributing to high carbon emissions.

This reliance on an inefficient road network has also hindered the country's ability to meet its European Green Deal obligations. The Romanian government, through its National Recovery and Resilience Plan (PNRR), has recognized the need for substantial investments in new highways and road modernization projects. However, progress has been slow, and more aggressive measures are needed to meet EU standards (Romanian Ministry of Transport, 2022).

4.2. Rail Transport

Rail transport in Romania has the potential to play a significant role in reducing congestion on roads and lowering carbon emissions, particularly for freight transportation. Rail systems are inherently more energy-efficient than road transport, and the EU has emphasized shifting freight traffic from roads to rail as part of its environmental and transport objectives (European Commission, 2021). Romania ranks sixth in the EU in terms of rail network length, with approximately 10,500 kilometers of railways. Despite this, the country's rail infrastructure is in poor condition, with frequent delays, low speeds, and unreliable services (Romanian Court of Auditors, 2021).

Countries like Germany and France have heavily invested in high-speed rail networks, boosting freight and passenger transport efficiency. In contrast, Romania's rail freight sector has seen little improvement, with average freight speeds of only 40 km/h, one of the lowest in the EU. The limited electrification of the network, outdated rolling stock, and poor maintenance have further hindered the growth of rail transport in Romania. As Romania seeks to align with EU sustainability goals, electrification and modernization of the rail system must become priorities for the government (Stoian & Burduja, 2018).

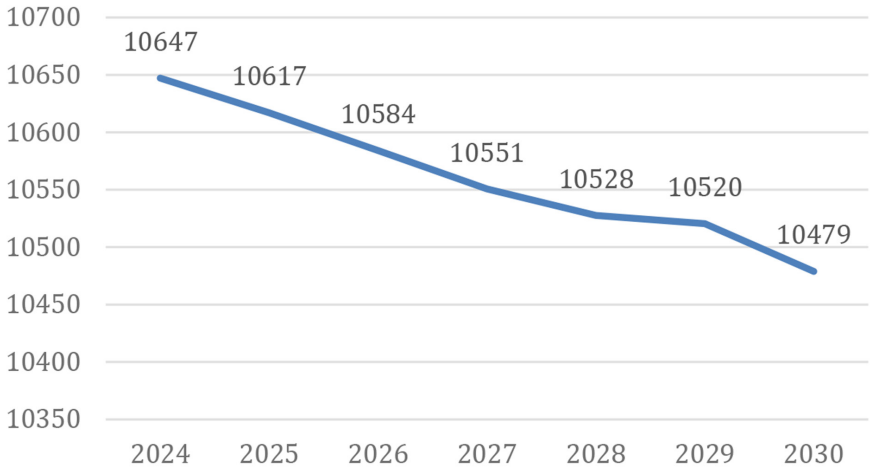

Figure 1. Estimates of the length of railways in operation in Romania from 2024 to 2030
Source: Own processing of data from National Institute of Statistics (n.d.)

4.3. Inland Waterway and Maritime Transport

Romania's strategic location along the Danube River and access to the Black Sea provide it with significant opportunities in maritime and inland waterway transport. These sectors are essential for Romania's trade, particularly in the transport of bulk goods such as coal, steel, and agricultural products. However, inland waterway transport remains underutilized, as the infrastructure along the Danube requires significant upgrades, including dredging and modernization of port facilities.

The Port of Constanța, one of the largest in the Black Sea region, plays a vital role in Romania's external trade. However, maritime transport's environmental impact is becoming a growing concern, with shipping in the Black Sea contributing to underwater noise pollution and greenhouse gas emissions (European Maritime Safety Agency, 2022).

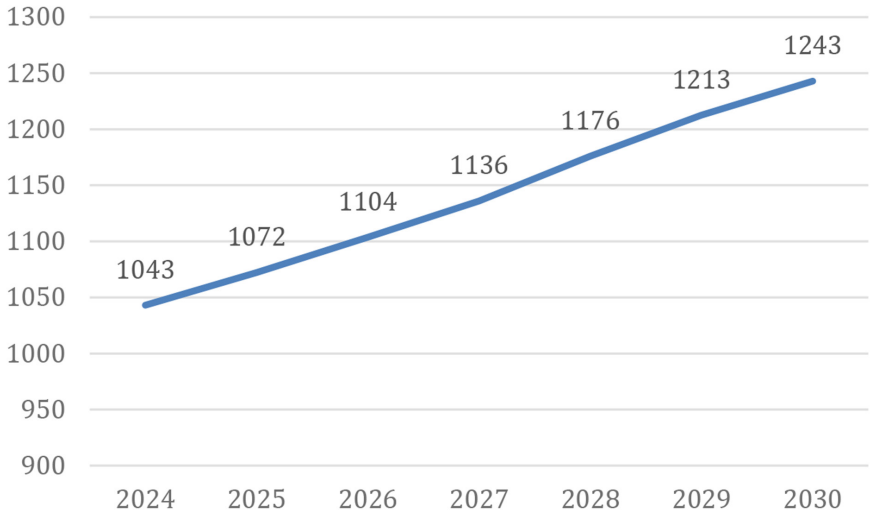

Figure 2. Forecasts regarding the length of highways in Romania 2024-2030
Source: Own processing of data from Eurostat (2023)

Romania must adopt greener technologies such as hydrogen-powered ships to mitigate these environmental impacts and align with EU maritime sustainability goals (European Maritime Safety Agency, 2022).

4.4. Air Transport

Romania's air transport sector has grown substantially in recent years, driven by increased investment in airport modernization, much of it funded by the EU. Low-cost carriers have also contributed to the growth of air traffic, facilitating greater mobility for passengers and stimulating tourism and business opportunities. Despite this, the environmental impact of air travel cannot be overlooked. Carbon emissions from aviation are on the rise, and Romania, like other EU countries, faces pressure to adopt more sustainable aviation practices.

The International Civil Aviation Organization (ICAO) has recommended the use of sustainable aviation fuels (SAF) and improved air traffic management systems to reduce emissions. Romania needs to integrate these sustainable practices to meet EU climate targets and ensure the long-term viability of its growing aviation sector (ICAO, 2020).

5. PROPOSED INNOVATIONS AND SUSTAINABLE SOLUTIONS

5.1. Electrification and Hydrogen-Powered Transport

A key strategy for reducing carbon emissions in Romania's transport sector is electrification. Romania has made some progress in electrifying its railways, but only 37% of its network is currently electrified, well below the EU average. Countries such as Germany and the Netherlands have electrified over 60% of their networks, demonstrating the gap Romania needs to close (Eurostat, 2023).

Hydrogen-powered transport presents another opportunity, particularly in regions where electrification is not feasible (International Energy Agency, 2021). Hydrogen-powered ships, such as those developed by the Compagnie Maritime Belge, have also shown promise in reducing emissions in the maritime sector (Compagnie Maritime Belge, 2022).

5.2. Smart Transit Systems

Smart transit systems, which integrate digital technologies into transport infrastructure, offer significant potential for improving transport efficiency and sustainability. The use of real-time data, intelligent traffic management systems, and multimodal transport hubs can greatly enhance Romania's connectivity, particularly in facilitating trade between Europe and Asia. Smart transit systems would also help reduce congestion, improve road safety, and lower carbon emissions.

Investment in smart technologies, such as automated traffic management systems and integrated public transport platforms, is critical for the modernization of Romania's transport infrastructure. These innovations could help Romania optimize its transport networks and create a more seamless and sustainable system that meets both national and EU mobility needs (OECD, 2020).

6. COMPARATIVE PERFORMANCE OF ROMANIA'S TRANSPORT SECTOR IN THE EU

6.1. Highway and Road Safety Metrics

Romania continues to lag behind its EU peers in road infrastructure development and safety metrics. While countries like Spain, Germany, and France have invested in well-developed highway systems, Romania's highway network is far smaller, with slow progress in expansion. The

country's road safety record is also among the worst in the EU, indicating an urgent need for reforms, including improved enforcement of traffic regulations, better road design, and public safety campaigns (European Commission, 2021).

6.2. Rail Freight Transport

In rail freight transport, Romania underperforms compared to other EU countries. Germany and Poland, for example, transport significantly more freight by rail, benefiting from modern, high-speed networks and efficient logistics hubs. Romania, by contrast, suffers from aging infrastructure and a lack of investment, resulting in poor service quality and low competitiveness in the rail freight market. To improve its standing, Romania must focus on modernizing its rail infrastructure and liberalizing the rail market to encourage private investment and innovation (Romanian National Railway Authority, 2021).

7. FUTURE OUTLOOK AND FORECASTS FOR 2024-2030

7.1. Road and Rail Expansion

Projections for 2024-2030 suggest a gradual expansion of Romania's highway network. However, the pace of development is insufficient to meet both national mobility needs and the EU's ambitious infrastructure targets. The government needs to accelerate investments and streamline regulatory processes to ensure that road projects are completed on time (European Investment Bank, 2022).

In the rail sector, forecasts indicate that Romania may see a decline in the operational length of its railway network due to continued underinvestment. Without decisive action, Romania risks falling further behind other EU countries in rail freight transport and overall competitiveness (Eurostat, 2023).

8. FORECASTS FOR ROMANIA (2024-2030)

Between 2024 and 2030, Romania's transport sector will face significant challenges and opportunities. The country needs to modernize its road and rail infrastructure to meet both national mobility demands and EU sustainability goals. While gradual expansion of the highway network is expected, the pace of development may not be enough to close the gap with other EU countries. Romania also faces high road accident rates, and without substantial investments in road safety and infrastructure, this issue is likely to persist. On the rail side, underinvestment and outdated infrastructure are expected to continue slowing down the sector's growth. Electrification and modernization of the rail network are crucial if Romania is to align with EU environmental targets and shift more freight and passenger traffic from roads to rail, a more sustainable mode of transport.

The adoption of innovative solutions like electric and hydrogen-powered vehicles, as well as smart transit systems, will not only improve domestic connectivity but also enhance Romania's integration into the broader EU market, contributing to economic growth and helping the country meet its 2050 climate-neutrality goals.

9. CONCLUSION AND PROPOSALS

The future of transport in Romania between 2024 and 2030 is shaped by a critical need for modernization and alignment with European Union sustainability goals. Romania's transport infrastructure, particularly in the road and rail sectors, requires urgent investment and innovation to

close the gap with more developed EU countries. Although some progress is anticipated, such as the gradual expansion of the highway network, the current pace of development is insufficient to meet both national mobility demands and the ambitious EU targets. Without accelerated efforts to improve road safety, expand the highway network, and modernize rail infrastructure, Romania risks falling further behind its European counterparts. The rail sector, in particular, faces challenges due to aging infrastructure and low electrification, hindering its potential as a sustainable alternative to road transport. Significant investment in electrification and modernization is crucial for increasing efficiency and reducing carbon emissions.

References

Compagnie Maritime Belge. (2022). Hydrogen-Powered Ferries: Reducing Carbon Emissions in Maritime Transport.
European Commission. (2020). European Green Deal: Transforming Transport for a Climate-Neutral Future.
European Commission. (2021). Trans-European Transport Network (TEN-T) Policy.
European Investment Bank. (2022). Financing Transport Projects in Eastern Europe: Challenges and Opportunities.
European Maritime Safety Agency. (2022). Shipping's Contribution to EU Greenhouse Gas Emissions and Mitigation Measures.
Eurostat. (2023). Transport Infrastructure Statistics.
International Civil Aviation Organization. (2020). Sustainable Aviation Fuels: Policy Frameworks and Deployment.
International Energy Agency. (2021). Hydrogen in Transport: A Focus on Rail and Maritime Applications.
National Institute of Statistics (n.d.). https://insse.ro/cms/en
OECD. (2020). Smart Transit Systems: The Future of Transport.
Romanian Court of Auditors. (2021). Rail Infrastructure Report.
Romanian Ministry of Transport. (2022). National Recovery and Resilience Plan (PNRR).
Romanian National Railway Authority. (2021). Strategies for Modernizing Romania's Rail Network.
Stoian, M., & Burduja, S. (2018). Transport Policies and Development in Romania.

Additional reading

European Environment Agency. (2022). Environmental Impact of Shipping in EU Waters.
European Parliament. (2019). Transport Emissions and EU Policy: Reducing Greenhouse Gases by 2030.
Romanian Institute for Transport and Logistics. (2022). Future Trends in Romania's Transport Infrastructure.
UN Economic Commission for Europe. (2020). Sustainable Transport Development: Trends and Challenges in Eastern Europe.
World Bank. (2021). Romania's Infrastructure Investment Strategy: Opportunities and Challenges.