



**Call for Papers “The European Green Deal: moving to action
Opportunities and challenges for the European citizens”**

**SUSTAINABLE AND GREEN TRANSITION FOR TRANSPORT INFRASTRUCTURE
IN ROMANIA
CASE STUDY: THE METROPOLITAN TRAIN CONCEPT IMPLEMENTATION**

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EXECUTIVE SUMMARY

Transport emissions represent around 25% of the EU's total greenhouse gas emissions. The European Green Deal is meant to provide efficient, safe and environmentally friendly transport. The European goal of being the first climate-neutral continent by 2050 requires, among others, ambitious changes in the continental transport system. The main aim of this paper is to provide an overview of actions for sustainable and smart transport in the European Union, to analyse the main developments and trends related to the Green Deal strategy and also to present the transposition of sustainable and green transport policy within the Romanian national transport strategies and to analyse the strategic framework for the metropolitan train concept implementation. The research methodology focuses on the analysis of green policies applied in the European Union, the use of GIS techniques, applying cartographic and statistical methods and also on providing guidelines for the creation and the implementation of the strategies for green transition in the transport sector.

Social Media summary

The paper analyses the prospects for sustainable and green transport policy within the Romanian national transport strategies, against the backdrop of the European Green Deal.

Keywords

#strategy #transport #green #infrastructure #train #sustainability

Short bio

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Table of Acronyms

AFIR	Regulation on Alternative Fuels Infrastructure
CEF	Connecting Europe Facility
CNG	Compressed Natural Gas
CO₂	Carbon dioxide
DNSH	Do No Significant Harm
EC	European Commission
EEA	European Environment Agency
ERS	Energy from renewable sources
ERTMS	European Railway Traffic Management System
EU	European Union
FC	Cohesion Fund
FEDR	European Regional Development Fund
FF55	Fit For 55
GHG	Greenhouse gas emissions
GPL	Liquefied petroleum gas
GTMP	General Transport Master Plan of Romania
IP	Investment Plan for the development of transport infrastructure for the period 2020-2030
IRR	Internal Rate of Return
JTF	Just Transition Fund
LIOP	Large Infrastructure Operational Program 2014 - 2020
LNG	Liquefied natural gas
LPG	Liquefied petroleum gas
MFF	Multiannual Financial Framework
MTI	Ministry of Transport
MTI	Ministry of Transport and Infrastructure
MTIC	Ministry of Transport, Infrastructure and Communication
NO_x	Nitrogen oxides
NRRP	National recovery and Resilience Plan
NTM	National Transport Model
PM	Particulate matter
POAT	Program Operational Transport 2021 - 2027
RES	Renewable energy
RRF	Recovery and Resilience Facility
RRP	Recovery and Resilience Plan
RO - LA	Combined transport Rollenden - Landstrassen
RRM	Recovery and Resilience Mechanism
TCU	Traffic Condition Index
TEN - T	Trans-European Transport Network
TEN – T	Trans-European Transport Network Comprehensive



Comprehensive

TEN - T Core Trans-European Transport Network Core

TOP Transport Operational Plan for 2021-2030 period

UN United Nations



1. Introduction and the general context

The European Commission outlined in the Annual Sustainable Growth Strategy 2020 and the European Semester Spring and Summer Package 2020 that the European Semester should help achieve the implementation of the European Green Deal, the European Pillar of Social Rights and the UN Sustainable Development Goals (European Union, 2021a).

The European Green Deal represents the strategy aimed at making Europe the first climate-neutral continent by 2050 (European Union, 2021b). For achieving this goal, the strategy contains a set of policy initiatives and legislative proposals that chart the path towards reaching this goal. Creating a climate-neutral, resource efficient, and overall sustainable economy requires a deep and comprehensive economic and societal transformation (Widuto, 2021).

In the context of the European Green Deal, by 2050, Europe should reduce emissions (CO₂, NO_x, PM) from transport by 90% on all means of transport (European Commission, 2019). To achieve this target, it is recommended to: impose stricter standards in terms of pollution resulting from road transport; digitization of transport, by increasing automated mobility; stimulating multimodal transport; improving public transport (including the implementation the concept of metropolitan train); implementing an automated traffic management system meant to decongestion urban traffic; implementing smart applications and mobility as a service.

In the context of the European transport policy, which provides an integrated European network oriented towards the development of a core network, with a deadline of 2030, (TEN-T Core) and a global network that will support the core network, with a deadline of 2050 (TEN-T Comprehensive) (**Error! Reference source not found.**), Romania will have to accelerate investments in transport infrastructure (Katz & Shapiro, 1994), oriented towards the development of transnational multimodal corridors that cross Romania, namely: Rhine-Danube Corridor and East / East-Mediterranean Corridor (**Error! Reference source not found.**), correlated with specific national priorities in line with Green Deal policies.

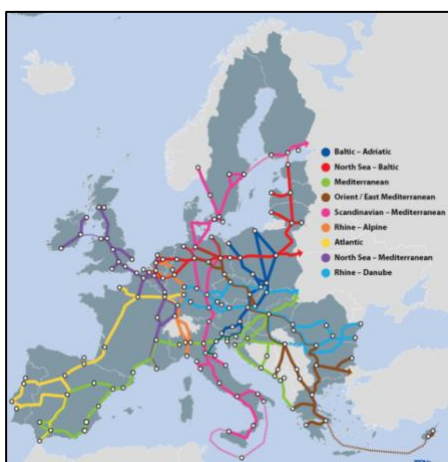


Figure 1. TEN-T Core Network Corridors (Freight and Passenger). Source: European Commission, Directorate General for Mobility and Transport, TENtec Information System

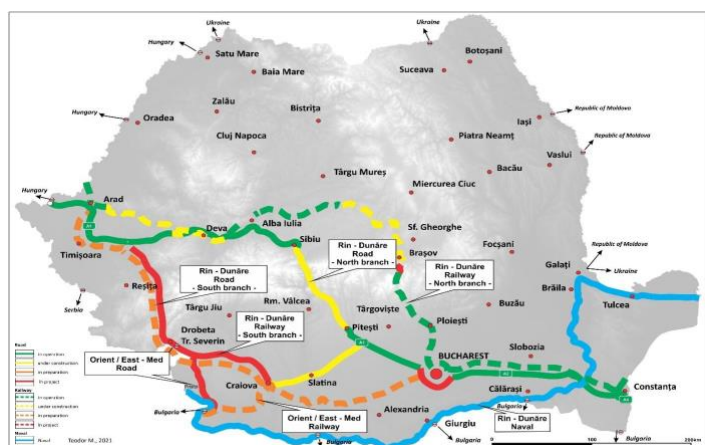


Figure 2. Rhine-Danube Corridor and East / East-Mediterranean Corridor in Romania and the stage of implementation. Source: Own construction



In the 2021-2027 budgetary period, at least 30% of the total EU budget and the Next Generation EU instrument will contribute to climate-related action. The Cohesion Policy objectives are dedicated to a greener Europe and fosters investment in clean energy, the circular economy, climate change mitigation and sustainable transport (European Union, 2021a).

Next Generation EU is more than a recovery instrument to help repair the immediate economic and social damage brought about by the coronavirus pandemic (European Union, 2021c). It will contribute to achieving a green, digital and resilient recovery of the economy and will also bring additional money to other European programmes or funds such as Horizon Europe, InvestEU, Recovery and Resilience Facility (RRF), European Agricultural Fund for Rural Development, REACT-EU or the Just Transition Fund (JTF). According to the Green Deal initiatives, the year 2021 was dubbed the European Year of Rail (European Commission, 2021a). This initiative was an opportunity to highlight the benefits of rail as a smart, sustainable, multimodal and safe means of transport.

The Connecting Europe Express was the event that took place in Europe between 02nd September and 07th October 2021 being one of the actions within the Green Deal, together with the Suitable and Mobility Strategy, highlighting one of the most sustainable, innovative and safest modes of transport and encouraging the use of rail by both people and freight and to contribute to the EU Green Deal goal to achieve climate neutrality by 2050. In this context, Romania had the opportunity to promote the implementation of the most important transport projects in order to align with other European countries.

The context is ripe in Romania for developing the policy path towards EU Mobility (European Commission, 2021b), against the backdrop of the European Green Deal (European Commission, 2019) and for effectively contributing to the achievement of the EU Strategy on Suitable and Smart Mobility (European Commission, 2021d).

2. The actual context in the Romanian transport strategy

The European Commission has proposed a Multiannual Financial Framework to ensure that EU funding is focused on results and creates strong incentives for Member States to effectively deliver on the Europe 2020 objectives and targets through the Cohesion Policy (European Commission, 2014). For accessing the European funds for investments, Member States had to meet the *ex-ante* conditions and had to develop national and/or regional “smart specialisation” strategies, comprehensive transport plans, in line with the National Reform Programmes, to ensure the consistency of transport investment priorities with the TEN-T Guidelines and to provide a long-term framework for the development of the different transport modes, identifying strategies, priorities for funding, with clear criteria for fulfilment. The plans had to set priorities in order to contribute to the single European Transport Area either in connecting main nodes of the TEN-T network or in enhancing regional mobility (Figure 1, Figure 2). It was important to build competitive advantage by developing and matching research and innovation with the business sector’s pragmatic needs in order to capitalize on emerging opportunities and market developments in a coherent manner, while avoiding duplication and fragmentation of efforts (European Commission, 2014).



The *General Transport Master Plan of Romania (GTMP)* was created to establish the contribution to the Single European Transport Area in accordance with the Regulation (EU) No 1315/2013 of the European Parliament and of the Council (European Commission, 2013), including priorities for investments in the central and global TEN-T network (Figure 3, Figure 4), as a condition of the European Union. The GTMP defines the transport infrastructure priorities in Romania and represents the strategic document for major interventions planning for 2016-2030 period that are significant for transport objectives on a national scale and it is agreed with the European Commission and approved by Government Decision No. 666/2016 (MT, 2016). The GTMP includes measures needed to ensure increased accessibility and connectivity for all regions of the Union, ensuring the optimal integration of transport modes and interoperability within transport modes, building missing links and removing bottlenecks, especially in cross-border sections, promoting the efficient and sustainable use of infrastructure, improving and maintaining the quality of infrastructure in terms of safety, security, efficiency, climate (MT, 2016).

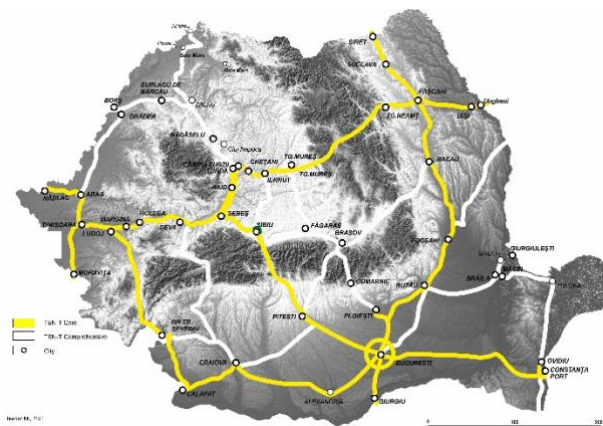


Figure 3. TEN-T Core and Comprehensive roads corridors in Romania. Source: Own construction

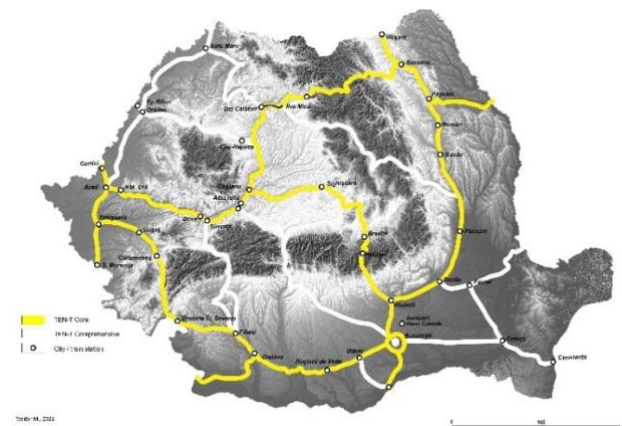


Figure 4. TEN-T Core and Comprehensive railway corridors in Romania. Source: Own construction

The GTMP was complemented by the *Implementation Strategy* that defines the projects prioritization, project scheduling program, the implementation period and the funding sources. The ranking of projects, for the five modes of transport, was based on the value of the internal rate of return of the project (IRR), value that was determined with the National Transport Model following the running of the transport network, overlapping with the TEN-T Core / Comprehensive network and impact on NATURA 2000 sites (MT, 2016). The resulting final score, for each project, established the ranking of projects that were subsequently included in the implementation strategy for the allocation of funding sources.

Romania is actively engaged in the process of developing transport infrastructure as a condition for sustainable development to ensure economic growth, job creation in the economy, as well as to improve the mobility of the population and the business environment on a European market in continuous growth dynamics and economic competitiveness (MT, 2020). For Romania, the development of transport infrastructure represents a medium- and long-term strategic objective, in all specific sectors: road transport, railway transport, naval transport and air transport (Teodor, 2018).



3. The suitable and green transport reflected in the new transport strategy in the Romania

Currently, the transport sector generates a quarter of total greenhouse gas emissions in Europe. The highest contribution is given by the road sector (72%) followed by the air sector (14%) and the maritime sector (13%). EU's transport emissions increased in 2019 by 0.8% (not including shipping), and also 0.9% increase in 2018. These rates of increase are the slowest since 2014. Projections based on existing policy measures in EU Member States indicate that transport emissions will increase 32% by 2030 compared to 1990 levels (European Environment Agency, 2021).

In the context of Green Deal policies, by 2050 Europe should reduce emissions (CO₂, NO_x, PM) from transport by 90% on all modes of transport (European Commission, 2019) (Figure 5. , Figure 6.). All transport sectors will have to contribute to the 55% reduction of GHG emissions by 2030 compared to 1990, and will have to increase about 24% the renewable energy in transport. (European Parliament, 2021). The European Commission has long been a proponent of sustainable mobility plans integrated in urban planning, making use of active travel options, reducing congestion and promoting more sustainable modes of transport (Soone, 2020).

Reducing people's climate and environmental footprint can be achieved by increasing the efficiency of vehicles, strengthening the shift to sustainable modal choice practices and by transition to Mobility as a Service (European Parliament, 2021). Reducing individual transport and facilitating the public mobility would be the most effective factors in the sustainability transition. For achieving this, public authorities and private partners also need to provide more integrated mobility solutions.

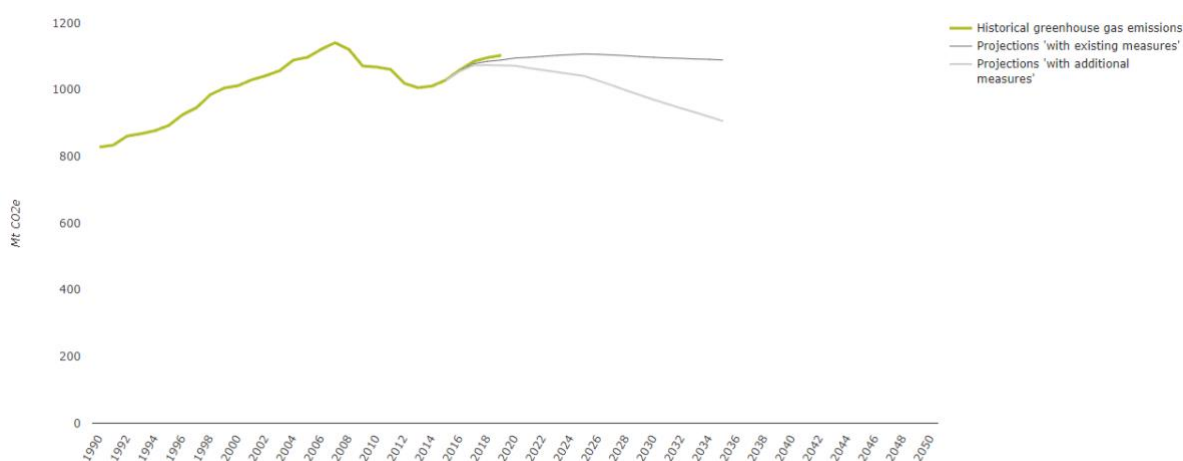


Figure 5. The trend in the greenhouse gas emissions in the transport sector since 1990 and projections to 2035, at EU level. Source: European Environment Agency (EEA).

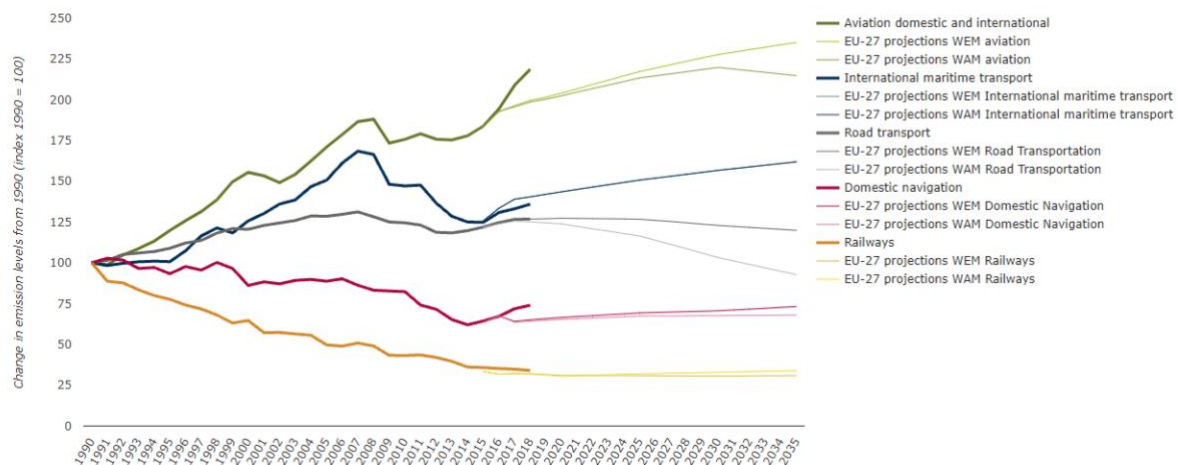


Figure 6. . The trend in the greenhouse gas emissions by transport mode and scenario since 1990 and projections to 2035, at EU level Source: European Environment Agency (EEA).

What is more, it is recommended to impose stricter standards in terms of pollution resulting from road transport, digitization of transport by increasing automated mobility, stimulating multimodal transport, improving public transport (including by implementing the concept of metropolitan train and park & ride), implementing an automated traffic management system to facilitate decongestion of urban traffic, reducing pollution in ports, implementing of intelligent applications and mobility as a service. The European Commission will consider legislative measures to stimulate the production of alternative fuels for all modes of transport and financial support for the creation of the charging point network. The list of legislative measures includes the revision of the Alternative Fuels Directive (AFIR - FF55) and the Trans European Network – Transport (TEN-T) Regulation.

The Green Deal represents a new strategy aimed at transforming the European Union into a fair and prosperous society, with a modern, competitive and resource-efficient economy, free of net greenhouse gas emissions and economic growth should be decoupled from the use of resources. The EU has proposed a strategy outlining how it wants to transform the EU transport sector and align it with the European Green Deal, by making it green, digital and resilient (Pape, 2021). This is the most important European strategy of the moment because it will direct financial allocations for investments in the next Multiannual Financial Framework.

Another desideratum is to increase the transport of goods on less polluting modes of transport such as rail or naval (internal transport of goods currently 75% by road and it is recommended to be done in the future by road, rail and/or inland waterways). In this regard, it is recommended that measures be taken to ensure better management of railways and inland waterways and to increase their capacity (European Commission, 2019).



3.1. The Investment Plan for Transport Infrastructure Development for the 2021-2030 period

Considering the transition period between the two multiannual financial frameworks 2014-2020, respectively 2021-2027, and the fact that the *General Transport Master Plan of Romania* was adopted in 2016, the Ministry of Transport and Infrastructure is developing the *Investment Plan for Transport Infrastructure Development for the period 2021-2030 (IP)*. It is the programmatic reference document for relevant public policies in achieving the objectives of national transport infrastructure. The scope of this document is to *update the GTMP Implementation Strategy* (MTIC, 2020).

The Cohesion Fund, the European Regional Development Fund and the Connecting Europe Facility will support urban mobility by promoting sustainable and multimodal mobility, infrastructure (public transport, active mobility) and clean fleets.

The Investment Plan has as main benchmark socio-economic efficiency, recalibrating investment objectives through a multicriteria analysis, starting from projects already completed and those in progress, identifying future needs and sources of funding, proposals for measures to improve the implementation process and a series of horizontal measures throughout the transport sector (MTIC, 2020). Currently, the final version of the Investment Plan is reaching the final stages of negotiation with the European Commission. It will be the ideal context for implementing the new policies in alignment with the European clean transport trends, and also for preparing the framework of the metropolitan train implementation.

The Investment Plan for the development of transport infrastructure for the period 2020-2030, aims at a paradigm shift in the sense of focusing Romania's political, institutional and financial efforts on a clear set of priorities, leading to the end of the decade 2020-2030 to the creation of a national transport network representing the backbone of Romania's development (MTIC, 2020).

A perspective on *road transport* is given by the use of hybrid cars and alternative fuels (CNG, LPG, Hydrogen). The European Commission will support the installation of public recharging and refuelling points. By 2025, it is expected that approximately 1 million public recharging and refuelling stations will be needed at European level for zero-emission and low-emission vehicles. In Romania, it is desired that the filling stations along the speed roads be equipped with electric charging stations and fast charging. As far as possible, it is desired that the technological roads in the vicinity of the motorways be transformed into bicycle lanes.

Rail transport plays a significant role in reducing greenhouse gas emissions in the field of transport, being one of the most environmentally friendly and energy efficient modes of transport. Rail transport is largely electrified and emits much less CO₂ than an equivalent road or air travel. Rail transport currently accounts for only 2% of the Union's total energy consumption in the transport sector and is the only mode of transport with steady reductions in CO₂ emissions since 1990, given the increase in transport volumes. In 2016, rail transport accounted for about 0.5% of CO₂ emissions from all modes of transport. It is important for the new strategies to provide rehabilitation, modernization and electrification works of the railway line, modernization of railway stations, level crossings, rehabilitation works for bridges and tunnels.

Romania has the intention of introducing RO-LA combined transport (Rollenden-Landstrassen). The advantages of this type of transport are multiple such as: the reduction of fuel consumption, the reduction of truck wear, the reduction of public road wear, the reduction of the number of trucks on public roads, the reduction of tolls for road transporters, the observance of rest times for



drivers without transport interruptions or reducing the impact on the environment. Another advantage is that the train can run all year round, every day of the week (Minarik, 2021). The RO-LA programme is part of Romania's National Policy in the field of renewable energy (RES), in order to correlate with energy savings and increase energy efficiency, important components of the package of measures needed to reduce greenhouse gas emissions and for compliance with the Kyoto Protocol to the United Nations Framework Convention (UNTC, 2021) and the Paris Agreement on climate change (European Commission, 2016).

The *air transport* aims to create a common European airspace (single European sky) in order to allow a substantial reduction in emissions from the aviation sector (approximately 10%) (European Commission, 2019).

It is necessary for *naval transport* to include policies to reduce greenhouse gas emissions by installing LNG supply (Sharples, 2019) infrastructure in ports (Constanța Port and Galați Port). Onboard water supply and inland waterway installations are currently in operation in all ports included in the TEN-T network. In accordance with the feasibility studies, the possibility of building or renewing the installations located in the central and global TEN-T ports will be evaluated, according to Directive no. 2014/94/EU, until the end of 2025 (European Commission, 2021g).

Multimodal transport has to be stimulated to ensure greater efficiency of the transport system. Automated and connected multimodal mobility will play an increasingly important role, alongside the intelligent traffic management system that has emerged due to digitalisation. The European Union's transport systems and infrastructures will be adapted to new sustainable mobility services that can reduce traffic congestion and pollution, especially in urban areas (Aldemir & Beldek, 2017).

3.2. The Recovery and Resilience Plan

The impact of the COVID-19 pandemic on all sectors of human activities, including transport, has been huge. The Recovery and Resilience Facility has a budget of 723.8 billion euro in loans (385.8 billion euro) and grants (338 billion euro) that is available to support reforms and investments undertaken by Member States and is closely aligned with the Commission's priorities ensuring a sustainable and inclusive recovery that promotes the green and digital transitions. By offering large-scale financial support for investment and reforms until December 2026, the Facility will better prepare Member States for a sustainable recovery (European Union, 2021b). The Recovery and Resilience Facility will financially support investments and reforms with a real and lasting impact on the economy and society, which support green transition, economic growth, social and economic resilience and job creation.

European Commission recognized the potential of investments in clean transport, renewable energies and clean hydrogen related to Green Deal in order to get the European economy growing and to accelerate the production and deployment of sustainable vehicles and vessels, as well as alternative fuels, and to help create more jobs by approving the European Recovery and Resilience Facility.

To benefit from the support of the Recovery and Resilience Facility, Member States had to submit to the European Commission their national recovery and resilience plans. Each plan sets out the reforms and investments to be implemented by end of 2026 and each plan should effectively



address challenges identified in the European Semester, particularly the country-specific recommendations of 2019 and 2020 adopted by the Council. It should also advance the green and digital transitions and make Member States' economies more resilient (European Union, 2021b).

The *National Recovery and Resilience Plan (NRRP)* represents an important strategic document for Romania. The European Commission has given a positive assessment for the Romanian national plan on September 27, 2021. The National Recovery and Resilience Plan brings the prospect of modernization and profound changes expected by the civil society, the business environment and the public sector in Romania. The NRRP is financed by 14.2 billion euro in grants and 14.9 billion euro in loans. The total allocation for reforms and investments that supports climate objectives is about 41% (railway modernization, urban mobility clean energy production, energy efficiency of buildings, biodiversity and environmental protection, digitalization of public administration, digitalization of health, digitalization of education, strengthening the public administration, social and territorial cohesion, fiscal sustainability, strengthened resilience of the health system).

The general objective of the NRRP is to establish Romania's national investment priorities and main directions of reform in accordance with the Specific Regulations of the European Commission in order to ensure the improvement of Romania's economic situation and to strengthen the resilience capacity at national level in times of pandemic crisis.

In order to reduce pollution in the field of transport, NRRP provides reforms and measures for all transport sectors such as the implementation of a charging system according to the "polluter pays principle" based on distance travelled, establishing programs to stimulate fleet renewal, increase road safety, develop railway infrastructure and railway traffic management, improving institutional management and corporate governance capacity, modernizing railway lines including the implementation of the European Railway Traffic Management System (ERTMS), centralization of stations, renewal and electrification of railway lines, but also the purchase of rolling stock sustainable, modernization of existing rolling stock and implementing a pilot sector of railway from hydrogen technology testing (MTI, 2021). National recovery plans should reflect the potential of innovation in the transport sector to drive growth (Soone, 2020).

The *sustainable transport component* also addresses the European flagship initiative Charging and Power in the 2021 from Annual Strategy for Sustainable Growth (European Economic and Social Committee, 2021), which promotes the use of sustainable, clean transport by contributing to the development of the network of electric charging stations. In accordance with the provisions of Regulation (EU) 2021/241 establishing the Recovery and Resilience Mechanism (European Commission, 2021h), an amount of at least 37% of the total allocation of NRRP must be *green transition expenditure*. The sustainable transport component contributes significantly to the climate target, of at least 37% of the total NRRP allocation as evidenced by the fact that at the level of the Transport component, climate change expenditure represents about 50% of the component allocation.

All investments and reforms proposed in the *sustainable transport component* of NRRP contribute to the green transition and respect the principle of DNSH (Do No Significant Harm), not having a significant impact on the six environmental objectives provided in Regulation (EU) no. 2020/852. Also, all investments in transport infrastructure will be made in compliance with environmental regulations and procedures (MTI, 2021). Supported reforms aim to reduce congestion, increase safety, encourage clean-up and multi-modality support.



The financial resources allocated for transport through NRRP is approximately 7.620 billion euros and will cover part of the total necessary investment at Romanian national level, so that, in order to maximize their impact, these resources will be directed to those interventions capable of generating the greatest added value in accordance with the strategies of the European Union and the national, during the implementation of the NRRP (MTI, 2021).

Support reforms aim to reduce congestion, increase safety, encourage clean-up and multi-modality support.

5. Case study: the Metropolitan train concept implementation in Romania

The European Union's financial support for the period 2021-2027 is aimed at ensuring long-term sustainability and achieving the objectives of the European Green Deal. Projects are supported to green public transport and improve infrastructure to help develop sustainable local public transport (discouraging the use of private cars, promoting zero-carbon cars).

COVID-19 affected the use of public transport and shared mobility services, as citizens migrated in preference towards private vehicles, but also walking (European Parliament, 2020). The Recovery and Resilience Mechanism will support urban mobility and transport decarbonisation. The aim is to speed up the use of sustainable, accessible and smart transport and to expand public transport to make European cities and regions cleaner.

The *metropolitan train concept* is a local or regional railway system that offers a public transport service for large urban areas, which ensures the mobility of the population in and around the big cities (Dobre, Teodor & Păunescu, 2018). The concept has been successfully implemented in various urban areas of Europe (Dobre, 2016). In order to meet the country-specific recommendations of the European Semester (European Commission, 2021e), it is necessary to implement initiatives meant to facilitate the green transition, with the potential for economic growth and job creation (Rodrigue, Comtois & Slack, 2016).

According to current Romanian legislation, the metropolitan train is not defined and the first references to the implementation of this concept were made starting since 2020 in the first draft version of the *Investment Plan (IP)*. IP strategy will include the concept of metropolitan train and the prioritization of investments based on an multicriterial analysis.

In Europe, the S-Bahn or RER metropolitan train (Vienna, Zurich, Paris, Munich, Berlin) often connects the central areas with the localities in the metropolitan area or in the proximity distance. According to an analysis presented by The European Rail Research Advisory Council (2016) in concert with attracting new customers, there is a need to generically improve Customer Access to the railway for improved access to rail services for a wider range of social groups. In the dense and urbanized metropolitan regions, it is expected that rail transit will retain its major role of reducing traffic congestion and the consumption of open space associated with driving and parking cars (The European Rail Research Advisory Council, 2014). The railway investment is very important (Michniak, 2015), from regional development point of view because of the regional economy improvements and because of the impact in living standard of inhabitants (Mańkowski, Weiland & Abramović, 2019).



Also, according to *Worldwide Traffic Congestion Ranking* (Traffic Index, 2021), Bucharest is situated on the 3rd position with a score for average traffic congestion index (TCI-42.51) and on the first place with the maximum TCI-135.81. Traffic congestion is a significant problem for other big cities in Romania such as Cluj-Napoca, Timișoara, Iași, Brașov etc., justifying a national approach. Given the growing traffic congestion in populated cities caused mainly by individual mobility, the *shift to rail* solution for shuttle traffic is supported by European examples.

In metropolitan areas, shuttle transport represents a significant percentage of the daily number of passengers. In Europe, as a solution to encourage urban and peri-urban mobility of passengers, with important effects on labour mobility, economic growth (Crescenzi & Rodríguez-Pose, 2012), road decongestion, reduction of pollutant emissions, the implementation of the metropolitan train solutions is marking the transition from private car to public passenger transport (Banister & Berechman, 2001).

At the strategic level, Romania is currently working on justifying the needs and identifying the benefits of decongesting traffic and increasing population satisfaction with the implementation of this transport service, looking on large urban agglomerations in Europe as a model.

At the same time, conditions are favourable for developing the *strategic framework for defining the concept of metropolitan train* in Romania and the *methodology for prioritizing large cities to benefit from non-reimbursable financing* for the implementation of this modern transport service system, being constrained by the fact that European non-reimbursable funds are limited compared to development needs. Thus, this concept can benefit from significant financing from the EC during this period, which is why it is *necessary to prioritize investments after creating a strategy* that shows the benefits as well as the implementation costs, taking into account the amount negotiated and allocated. According to the European Rail Research Advisory Council (2019), rail is the only mode of transport that provides the capacity needed on future transport systems, with reasonable land use in urban areas.

For an objective identification of the Romanian specific needs, but also for a transparent prioritization, in the analysis we take into account *all 41 the county seat cities in Romania and the most relevant factors that generate passenger traffic*. Thus, 144 possible railway routes were identified, with a total length of 1440 km. These metropolitan train routes could serve 1280 unique localities totalling 14.77 million inhabitants (**Error! Reference source not found.**).



Figure 7. Romanian metropolitan train background. Source: Own construction

The created methodology proposes the identification of the most relevant indicators and the application of a multicriteria score function.

The criteria taken into account in identifying the implementation needs of the metropolitan railway system are: the existing railway infrastructure (electrified and electrified – Figure 9) on a distance of 30 km from the central station of each analysed city (**Error! Reference source not found.**, Figure 10, Figure 11), the population served (for which an indicator was calculated based on the



total population of each route in relation to the number of kilometres of the route), the economic criterion (which takes into account the turnover, the number of economic agents, the number of employees of the county seat), the university indicator, connection to the airport, the tourist criterion (number of overnight stays), the gain of time compared to road transport on the same route, the gain on speed travel (given the congestion on the road sector). These criteria were weighted within the function and the scores obtained were used to prioritize the list of investments.

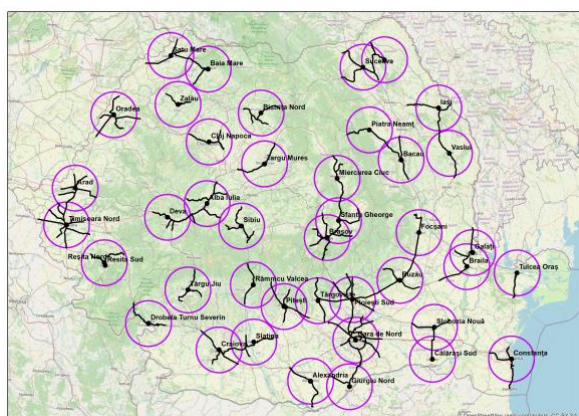


Figure 8. Extraction of railway lines at a distance of approx. 30 km from the main train station. Source: Own construction

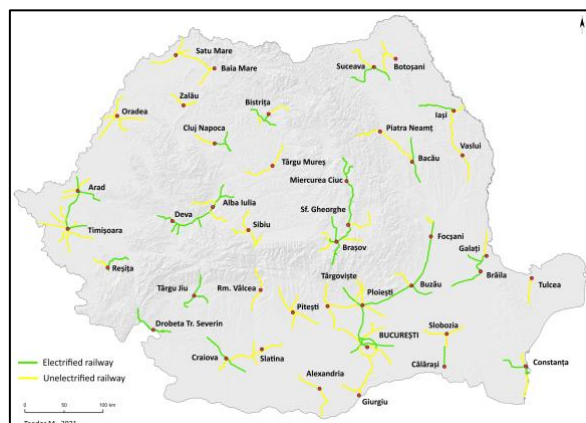


Figure 9. The actual stage of the railway (30 km distance). Source: Own construction

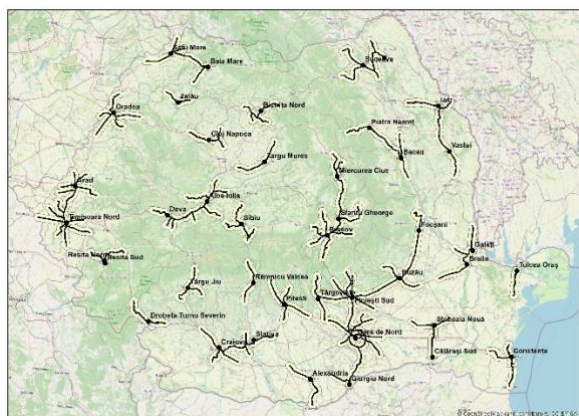


Figure 10. Creating a 5 km buffer area around the railway lines. Source: Own construction

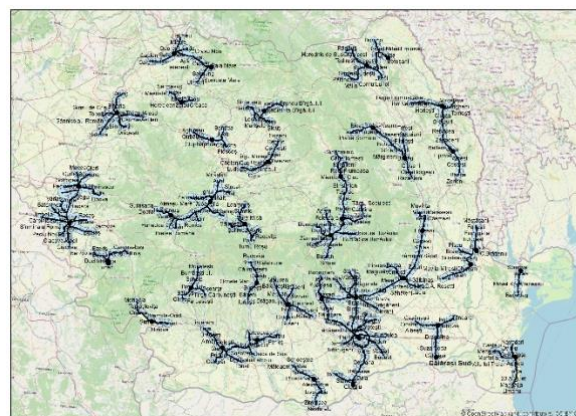


Figure 11. Identification of territorial administrative units in the buffer zone for all CF routes. Source: Own construction

According to the proposed formula, the prioritization showed that the five most important metropolitan train are represented by: București, Cluj-Napoca, Iași, Brașov and Constanța cities (Figure).

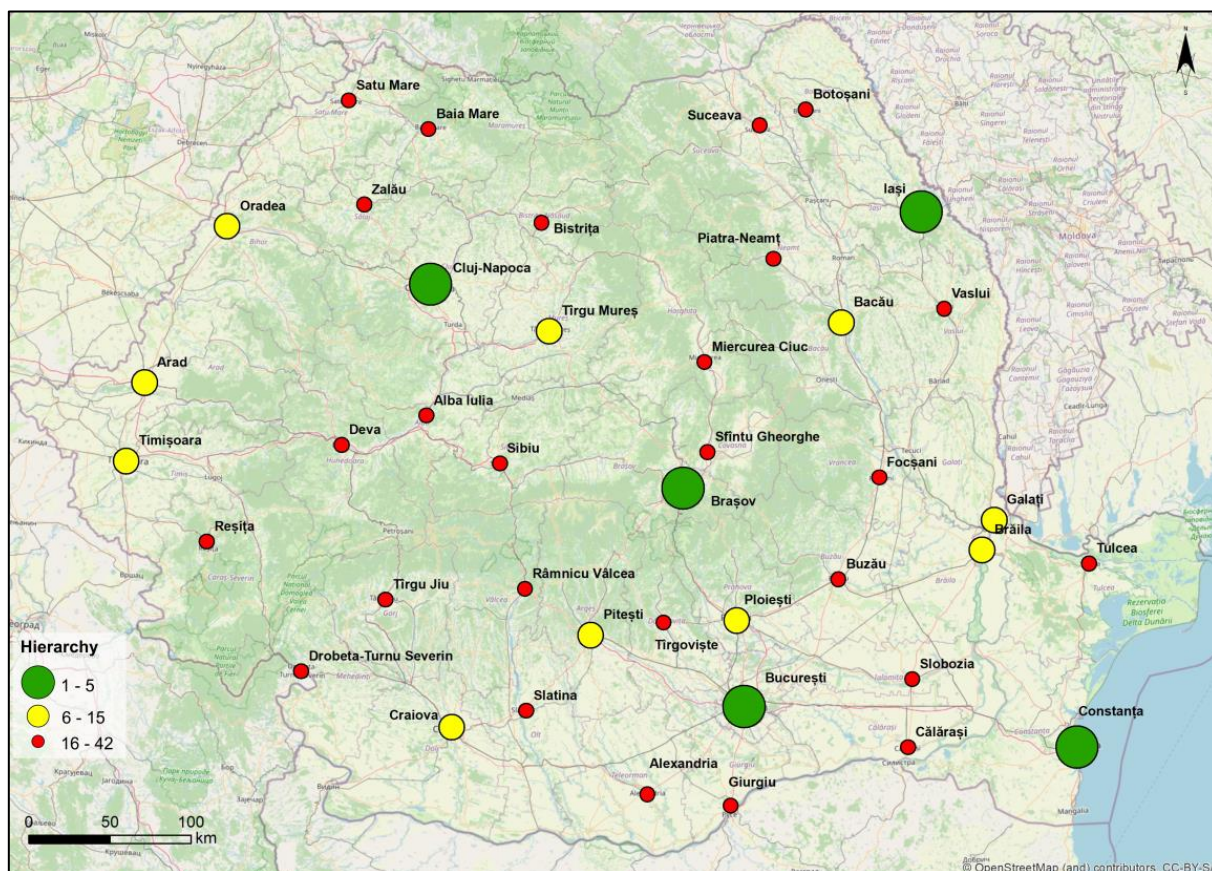


Figure 12. Metropolitan train hierarchy. Source: Own construction

Transport systems of the metropolitan train have great advantages because of the exclusive routes, so they are not exposed to delays due to traffic bottlenecks that occur often in the important roads of large cities (Mahla & Ovalle, 2010). Given the existing railway infrastructure in the big cities of Romania, the implementation of the metropolitan train could be achieved with minimal effort but with major benefits (Knowle & Ferera, 2014). Thevathasan and Balachandran (2007) carried out an analysis amongst Australian train passengers and discovered three different dimensions that had a significant effect on overall satisfaction: comfort, safety and facilities. Some examples of how the metropolitan train would look like, for the main cities of Romania (Figure , Figure , Figure) show that the network is suitable.

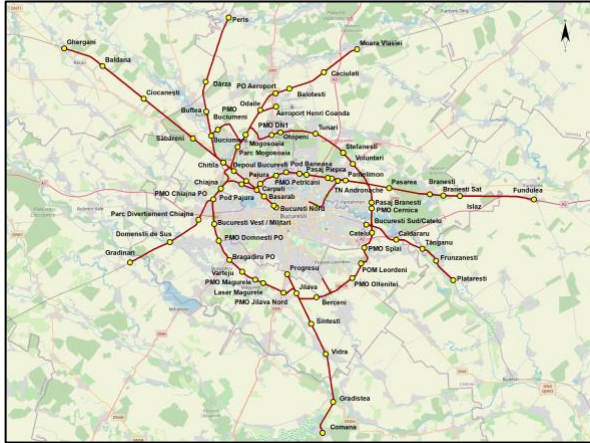


Figure 13. București metropolitan train.

Source: Own construction

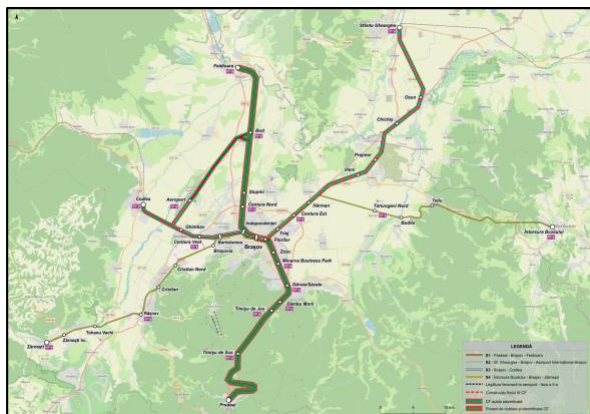


Figure 15. Brașov metropolitan train.

Source: Own construction



Figure 14. Sibiu metropolitan train. Source: Own construction

The success of the implementation of the metropolitan train depends on the conditionality of the existence of a railway network, to ensure the connection between densely populated areas and being complementary and connected to other public passenger transport.

6. Policy recommendations

- With climate change being one of the most pressing Global Challenges of the 21st century, a more nature-friendly urban transport system will benefit entire communities. Also, evolution of urban mobility trends will depend the pre-COVID-19 situation of each country, on the evolution of the pandemic and on policies that will be promoted and financed by the European Union.
- It is mandatory to transpose into strategic documents the identified needs of the country. Given the fact that the National Recovery and Resilience Plans are the new strategic



documents where the transport component is an important part, it is the ideal time to transpose the EU's objectives in accordance with Green Deal strategy.

- Considering the transition from the 2014-2020 programming period to the next financing period it is high time for implementing the new policies in alignment with the European clean transport trends, and for the preparation of the framework of the metropolitan train implementation.
- Modernization of the railway infrastructure as well as the acquisition of new rolling stock will be the main vectors for conversion and transfer of passenger and freight traffic from the road sector to the railway sector, according to the requirements of the White Paper on Transport (Shift to Rail concept), having multiple benefits in terms of reducing greenhouse gas emissions.
- With climate change being one of the most pressing Global Challenges of the 21st century, a more nature-friendly urban transport system will benefit entire communities.
- Promoting and funding the implementation of the most effective transport-related measures positively impacting the quality of life and the environment. In many European areas, the metropolitan train is complementary to metro transport, being a solution for decongesting road traffic with major environmental and life quality benefits. Such an investment in Romania, through the *Investment Plan for Transport Infrastructure Development for the period 2021-2030*, will support the concepts and visions of the European Union regarding the *New Green Deal policy* and the ones promoted through the *2021 European Year of Rail* action.

7. Conclusion

At EU level, urban mobility accounts for 40% of all CO₂ emissions of road transport and up to 70% of other pollutants from transport (European Parliament, 2020a). In order to achieve smart, suitable and inclusive growth, to stimulate job creation and to respect long-term decarbonization commitment, the Union needs to have an up-to-date, multimodal, high-performance infrastructure in all sectors to help connect and integrate the Union. Those connections will help improve the movement of persons, goods, capital and services (European Parliament and of the Council, 2021).

EU public transport operators have already started integrating and offering new mobility solutions, based on the Mobility-as-a-Service approach. Promoting public transport as cost-efficient and sustainable alternative to individual or motorized transport is an approach with multiple perspectives: supporting the mobility of people, reducing the level of greenhouse gas emissions and the level of pollutant emissions, decongesting the road network, etc. According to the *European Commission* (European Commission 2021f), rail transport *emits far less CO₂ than an equivalent journey by road or air, while being the only mode of transport that has consistently reduced its greenhouse gas emissions from 1990 to the present*. The option to promote rail transport is likely to generate considerable benefits in all areas. The revision of rules on vehicle emissions would provide an opportunity to further incentivise introduction of zero and low-emission vehicles.



In the context of the COVID-19 crisis, the necessity to strengthen the current framework and to receive direct financial support through an innovative tool is covered by the recovery and resilience facility, which promises to provide effective and significant financial support to step up the implementation of sustainable reforms and investments.

The Green Deal, the European growth strategy proposed in December 2019, and the European Recovery and Resilience Plan, recognise the potential of connected multimodal mobility and digitalised traffic management to improve sustainability in the transport sector.



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9. Annexes

The metropolitan train methodology in graphs: analysing the graphs below and the Pearson correlation coefficient (r^2), it is observed that there is a strong linear positive correlation between the hierarchy of the metropolitan train and some criteria (Figure , Figure 17.).

The correlation between the metropolitan train hierarchy and criteria: the and airport passengers' criteria and number of tourist nights spent shows a moderate positive correlation (0.59 and 0.69) (Figure , Figure).

A correlation of 0.50 shows that 25% variance is in common and a correlation of 0.10 shows 1% in common (Rummel, 1976) (**Error! Reference source not found.**, Figure , Figure). The value of 0.02 for r^2 (Figure 25) implies that there is not a linear dependency between the variables (Taraldsen, 2020, Hotelling, 1953).

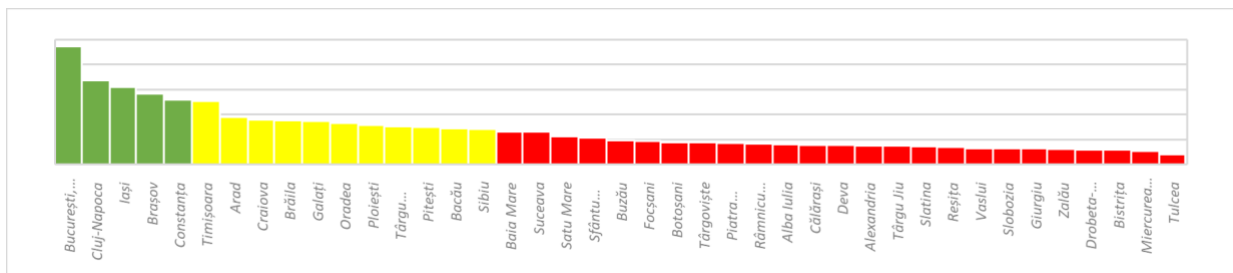


Figure 16. The metropolitan train hierarchy in Romania by applying the formula:

$$F = 40\%*C1 + 10\%*C2 + 10\%*C3 + 10\%*C4 + 10\%*C5 + 10\%*C6 + 10\%*C7 + 10\%*C8 + 10\%*C9. \text{ Source: Own construction}$$

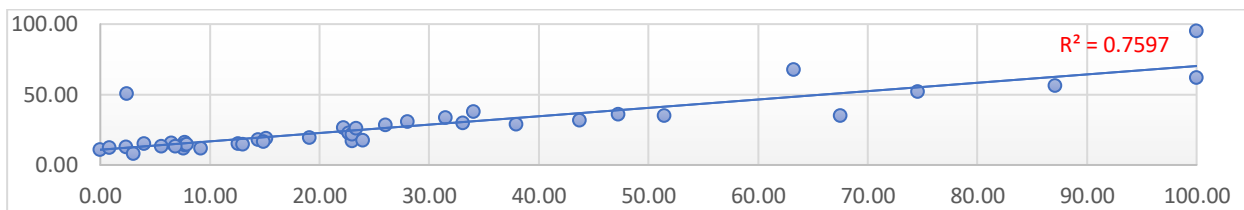


Figure 17. The correlation between the metropolitan train hierarchy and the population criteria - C1. Source: Own construction

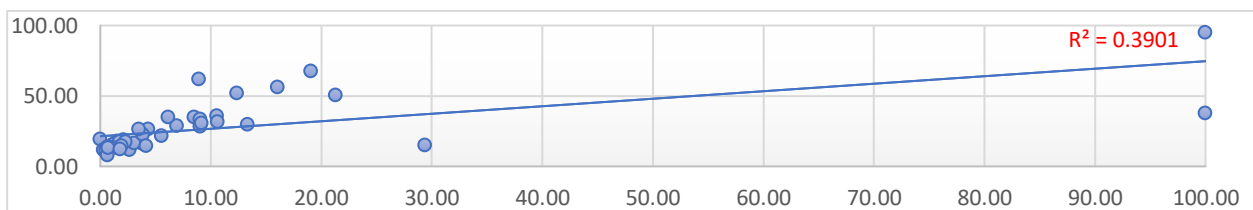


Figure 18. The correlation between the metropolitan train hierarchy and the turnover criteria – C2. Source: Own construction

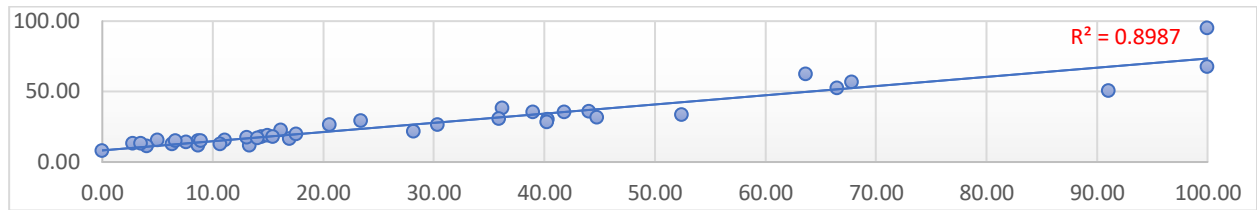


Figure 19. The correlation between the metropolitan train hierarchy and the number of economic agents' criteria – C3.

Source: Own construction

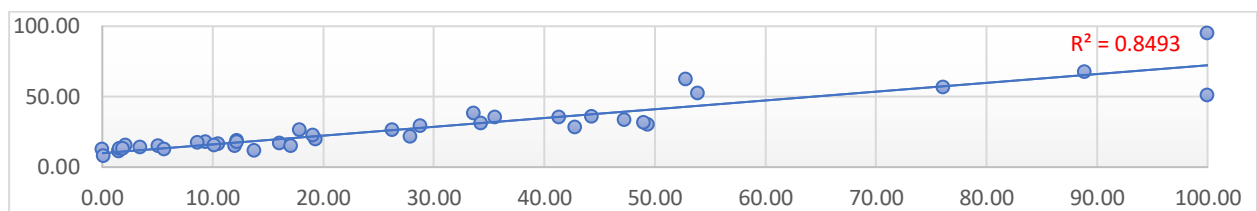


Figure 20. The correlation between the metropolitan train hierarchy and the number of employees criteria – C4.

Source: Own construction

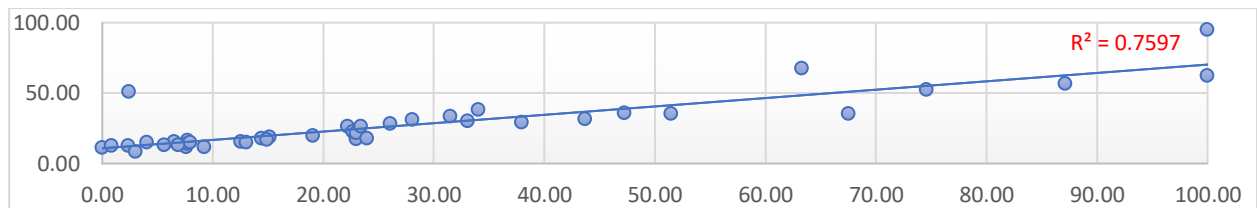


Figure 21. The correlation between the metropolitan train hierarchy and the university potential criteria – C5.

Source: Own construction

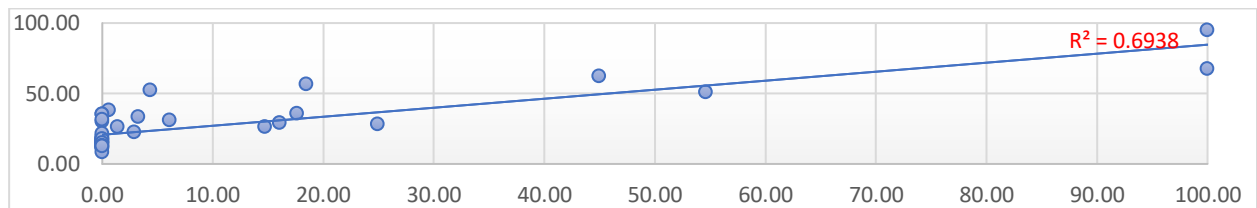


Figure 22. The correlation between the metropolitan train hierarchy and the airport passengers' criteria – C6.

Source: Own construction

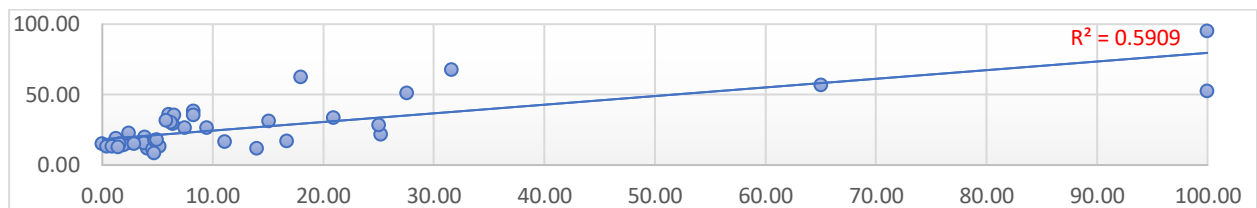


Figure 23. The correlation between the metropolitan train hierarchy and the number of tourist nights spent criteria – C7.

Source: Own construction

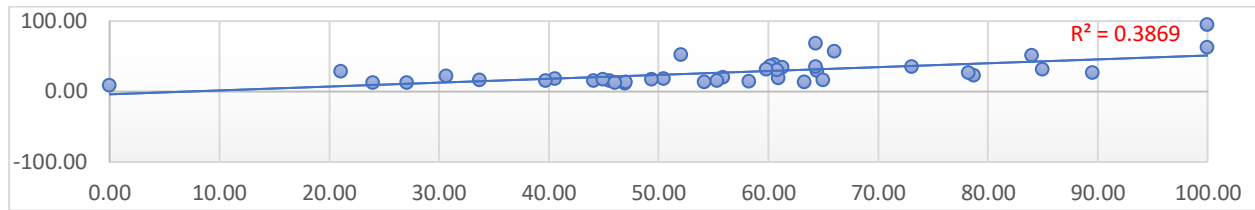


Figure 24. The correlation between the metropolitan train hierarchy and on the congestion criteria – C8.

Source: Own construction

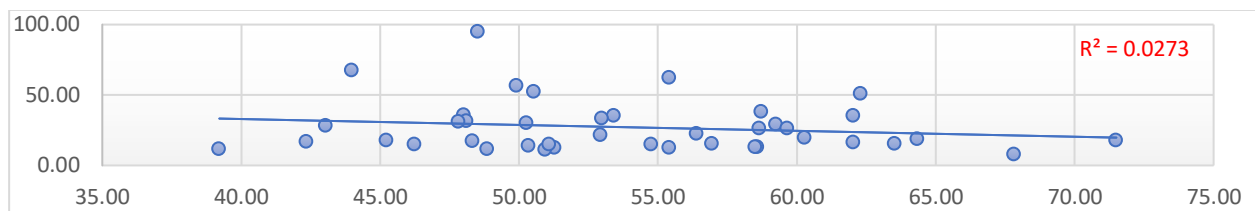


Figure 25. The metropolitan train hierarchy and the commercial speed criteria – C9. Source: Own construction