POPULATION ACCESSIBILITY TO RAIL SERVICES. INSIGHTS THROUGH THE LENS OF TERRITORIAL COHESION

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Abstract
Territorial cohesion is a concept that has played an important role in the European authorities' agenda since the 1990s, being linked to some of the main objectives defined in various EU Treaties (i.e. those envisaging flows, connectivity, spatial nodes, etc.). In this respect, the present research aims to explore territorial cohesion in relation to accessibility so as to provide a comprehensive picture of this subject, employing for the empirical study the Romanian railway system. The main objective is to examine how the Romanian railway infrastructure influences territorial cohesion through regions' accessibility to infrastructure and rail transport services. The research methodology consists of an exploratory study conducted using secondary data analysis. The collected data have been used to compute a set of indicators (the Engel ratio, the Goltz ratio, and the Hansen accessibility coefficient) that allows the analysis of the degree of population accessibility to railway transport, based on the characteristics of the rail transport service (distance, duration, and cost of travel). The study has revealed that the Romanian railway infrastructure does not have a positive contribution to reducing disparities and strengthening territorial cohesion. Although it is sufficiently extensive, it has uneven growth and low accessibility due to low travel speeds and long travel times. Regarding accessibility, the presence of at least two types of disparities – inter- and intra-regional, has been revealed, due to the fact that disparities in accessibility firstly manifest at the regional level and increase in intensity at the county level.

Keywords: territorial cohesion, population accessibility, railway network, inter- and intra-regional disparities, Romania
JEL classification: R1, R4, R42

1. Introduction

One of the most important goals of the European Union is to strengthen economic and social cohesion. It can be achieved by alleviating the social disparities and supporting solidarity with the disadvantaged social groups (vertical cohesion) and by decreasing regional disparities and strengthening the solidarity with the lagging regions' population (horizontal cohesion) (Constantin et al., 2010, Guastella & Timpano, 2010, Colak, 2015, Rastvortseva, 2017). As a result of this vision, the Treaty of Lisbon (2007) introduced a third dimension, namely territorial cohesion, which has become a basic pillar of the EU's regional policy.

As the EU harbors an incredible territorial diversity, territorial cohesion means that citizens should be able to make the most of the inherent features of the areas in which they live. No European citizen should be disadvantaged in terms of access to public services, housing, or employment opportunities simply by living in one region rather than another (European Commission, 2020).

Territorial cohesion is a concept that has played an important role in the European authorities' agenda since the 1990s. The term was popularized by Michel Barnier during his

term as European Commissioner for Regional Policy. Barnier made an explicit and detailed reference to the concept of territorial cohesion in the second European Union's report on the Member States' cohesion, which raised a complex debate about its meaning (Faludi, 2006, Constantin et al., 2013).

Also, territorial cohesion is a political concept that has been linked to some of the main objectives defined in various EU Treaties. In the second Cohesion Report (European Commission, 2001), the concept was associated with the objective of promoting a 'more balanced development' of the territory to achieve harmonious development of the European Union as a whole. The third Cohesion Report (European Commission, 2004) aimed to better clarify the concept, stating that „the concept of territorial cohesion extends beyond the notion of economic and social cohesion", further explaining that it helps „achieve a more balanced development by reducing existing disparities, avoiding territorial imbalances and by making both sectoral policies which have a spatial impact and regional policy more coherent. The concern is also to improve territorial integration and encourage cooperation between regions" (p. 27).

For this objective to be reached, an integrated approach is needed, based on better coordination between sectoral policies at each level, from local to European. It also entails closer cooperation and improved connections. Many issues - climate change, migration - do not respect standard boundaries and could be better addressed through a more tailored response from several regions or countries (European Commission, 2020).

The next step towards strengthening the territorial cohesion on the EU's political agenda was in 2009, when it was incorporated into the Treaty of Lisbon, together with the dimensions of social and economic cohesion. From this point on, territorial cohesion has become a fundamental concept, being also approached in the fifth and sixth EU cohesion reports (European Commission 2010, 2014). Further on, Territorial Agenda 2020 has stated that territorial cohesion is a common goal for achieving a more harmonious and balanced Europe, representing the EU's policy framework to support this vision. The Agenda provided strategic orientations for territorial development, ensuring that the territorial cohesion dimension is integrated into all policies at all governance levels. The Territorial Agenda 2020 defined six territorial priorities able to help at implementing successfully the Europe 2020 strategy. These priorities were: to promote polycentric and balanced territorial development, to encourage integrated development in cities and regions, to integrate the territorial dimension in cross□border and transnational functional regions, to ensure the global competitiveness of the regions based on strong local economies, to improve territorial connectivity for individuals, communities, and enterprises, as well as to manage and connect ecological, landscape and cultural values of regions (Council of the European Union, 2011). The Territorial Agenda 2030 proposes two main objectives, namely: a Just Europe and a Green Europe, being revised in order to respond to COVID-19 pandemic impact, thus outlining territorial cohesion's important role in the recovery process. The new territorial perspectives are focused on balanced territorial development utilizing Europe's diversity, convergent local and regional development, less inequality between places, better living and working across national borders, and on a Green Europe that protects common livelihoods and shapes societal transition (Council of the European Union, 2020).

The transport infrastructure is considered an important factor with an impact on territorial cohesion, thanks to its function of uniting intra- and multi-national spaces. The transport systems, including railways, are essential features of all modern economies, considered to be a critical engine for regional, economic, and social development. Transport plays an important role in increasing production and employment, reducing travelling time, and improving accessibility. All these effects have an impact on achieving territorial cohesion and on reducing regional disparities (Alexiadis & Ladias, 2011, Hirobe, 2020).

Based on these overall considerations, the present research aims to explore territorial cohesion in relation to the concept of accessibility, in order to offer a relevant view on this topic, with the Romanian railway system as the observed entity of the empirical study. The main objective is to examine how and to what extent the Romanian railway infrastructure influences territorial cohesion through regions' accessibility to infrastructure and passenger rail transport services. The choice has been made considering Romania's strategic location on the EU map, as a 'turntable' for population and goods flows between the West and the South-

East. Thus, the state of territorial cohesion in Romania in terms of accesibility to rail services can be considered an important piece in the broader picture of the EU's territorial cohesion. Accordingly, the paper is organised as follows. After Introduction, the second section addresses territorial cohesion from the perspective of rail infrastructure accessibility, in both conceptual and practical terms. The third section proposes an inquiry into population accessibility to rail transportantion in Romania, which is explored at development region (NUTS2) and county (NUTS3) level as well, opening the door for a comprehensive view on territorial disparities: thus, both inter- and intra-regional levels are brought into discussion. In this respect, it is unanimously acknowledged that the deeper territorial granularity, the more realistic image of disparities. In line with this idea, the final part of the third section places the spotlight on the South-West Oltenia region, which plays a very important role in connecting the South of Romania (with Bucharest, the capital of Romania, included) to the West region, a major gate to the Western Europe. According to the territorial accessibility index proposed by Teclean and Dragan (2020) and calculated at NUTS2 level for all EU countries, the South-West Oltenia region belongs to „areas with average spatial accessibility", i.e. second quartile of this index from bottom-up (p. 34). The final section conveys the main conclusions, with an emphasis on the recommended policy measures aiming at reducing territorial disparities and strengthening territorial cohesion when the passenger rail transport accessibility is taken into consideration.

2. Territorial Cohesion and Rail Infrastructure

The transport systems, including railways have a major contribution to reducing regional disparities and improving regions' competitiveness by facilitating trade and labour movement (Aldagheiri, 2010, Alexiadis et al. 2010).

Transport infrastructure leads to economic growth through several paths. Firstly, investments in infrastructure increase the demand for goods and services. Secondly, improving transport infrastructure reduces travel time with a direct impact on passengers and cargo carriers, which have fewer costs (Gunasekera et al., 2008). At the same time, the reduced travel time prompted by well-developed transport infrastructure can have economic consequences by supporting producers to access remote markets and obtain goods and therefore, stimulates local production. Thirdly, better infrastructure attracts foreign direct investments (Hong, 2007, Cechella, 2010, Sokolowicz, 2011, Khryseva et al. 2018), which have positive effects on economic growth. Finally, lower transport costs can accelerate industrial congestion and the concentration of economic activities (Hong et al., 2011).

Clear evidence of the transport infrastructure value and importance in the process of territorial cohesion is the European Union's interest in its development. Thus, the EU aims to transform transport policy into a policy of territorial integration so as the population from peripheral areas to have access to areas with a higher pace of development and to economic activities that would not normally be accessible in the transport infrastructure absence (Gallego et al., 2015).

2.1. Significance and dimensions of Territorial Cohesion

The concept of territorial cohesion is associated with achieving a „more balanced development by reducing the existing disparities, avoiding territorial imbalances and developing both sectoral policy with spacial impact and regional policy as coherently as possible" objective (European Commission, 2004, p.27). Subsequently, the Green Paper on Territorial Cohesion (European Commission, 2008) identified three elements that should be taken into consideration in any analysis of territorial cohesion, namely: territorial concentration - overcoming density differences, connectivity - overcoming distances, and cooperation - overcoming division.

The term was often associated with regional differences without a critical reflection on its content and many studies approached it in a descriptive manner to analyze certain economic and social conditions in and between EU regions (Weckroth & Moisio, 2020, Anastasiou, 2020). In the 2000 - 2006 and 2007 - 2013 programming periods, the territorial cohesion concept was employed to refer to the level of regional disparities in economic production, using the GDP per head as the main indicator. Since the third Cohesion Report in 2004, the

term was strongly connected with achieving the objectives of the Lisbon Agenda: competitiveness, innovation, and employment (Mirwaldt et al., 2008, Zaucha & Szlachta, 2017). Territorial cohesion was about increasing the regional performance in the new member states to lower the regional disparities, which would have had a positive impact on the economic output of the whole EU territory (Weckroth & Moisio, 2020).

However, territorial cohesion can be also approached from an individual perspective, is defined as a spatial condition where people should not be disadvantaged wherever they happen to live or work in the European Union (Commission of the European Communities, 2004). This definition changes the approach of territorial cohesion from the macroeconomic disparities between regions' perspective and focuses on individuals and their life conditions, relating it with accessibility. This perspective relies on the concept of "accessibility of services of general economic interest" initially introduced by the Amsterdam Treaty (Commission of the European Communities, 1997) and bringing a new political-economic component to the territorial cohesion. Relating territorial cohesion with accessibility represents a qualitative shift from European regions' economic performance to their structural strengths and weaknesses. The approach of territorial cohesion from an individual perspective has been used during the last few years and particularly throughout the last programming period- 2014-2020 (Weckroth & Moisio, 2020).

The subject was mainly approached in studies where authors tried to identify the main components and dimensions of territorial cohesion rather than for a widely accepted definition. The literature review reveals the existence of very few studies that attempted to identify these dimensions, in order to provide theoretical support for the development of a methodology that could lead to an effective manner of measuring the territorial cohesion of a territory. In addition to EU's cohesion reports, studies on this subject area include several analytical tools, part of the European Territorial Observatory Network programme (ESPON). In these studies, the main elements of territorial cohesion are identified based on the territorial challenges faced by EU and the objectives stated in the cohesion reports.

Consequently, the elements defining territorial cohesion can be summarised as follows: balanced territorial growth; territorial connectivity; territorial cooperation; territorial polycentricity; access to services and infrastructure; environmental sustainability; socio-economic cohesion; economic competitiveness; territorial governance, social inclusion, and the quality of life (Medeiros, 2016).

Based on these elements and the cohesion objectives, the main dimensions of territorial cohesion have been proposed (Zamora et al., 2017):

a) The economic dimension: in a territorial analysis, the economic dimension generally refers to capital resources invested and mobilized to make a profit. This action is important and necessary in face of the steady increase in global competition (Gonzalez et al., 2015). Also, the economic dimension should be a key element in ensuring territorial cohesion, in particular by strengthening the economic competitiveness of a territory, increasing employment, promoting innovation, productivity, and entrepreneurship.

b) The social dimension: the relationship between the economic and social dimension is extremely important for achieving cohesion. It is necessary to integrate social components into economic initiatives as well as to integrate economic components into social initiatives. Generally, social cohesion represents the implementation of measures that will create equal opportunities for people to exercise their fundamental rights, will guarantee well-being, and will support anti-discrimination policies. In this particular case, this dimension addresses issues such as equality, education and culture, health, social inclusion and security, poverty, demographic structure, and access to basic services.

c) The environmental dimension of any process is becoming significantly more important, being an integrated part of the objective of achieving a more coherent, harmonious, and balanced territory. Through this dimension, the environment is considered the basis of life and a fundamental element for development. This is determined by the idea that future development depends on the national and international actors' ability to exploit natural resources sustainably. In this respect, actions such as improved and sustainable management of environmental resources, including water, soil, air quality, biodiversity, and landscape, are taken into consideration. It also addresses climate change issues, including flood risk and the need for a low-carbon economy (Gonzalez et al., 2015).

d) The institutional dimension: to achieve territorial cohesion, joint interaction, and institutional agreements between social actors is fundamental. Integrated spatial development requires new forms of horizontal and vertical cooperation with the purpose of strengthening networks and partnerships. The objective of territorial governance can be a sine qua non condition for ensuring a more balanced development, oriented towards achieving territorial cohesion. Thus, this dimension includes variables that reflect good governance, electoral participation, and the efficiency and cooperation of public institutions (Medeiros, 2016).

e) The integrated spatial development dimension: the spatial dimension is crucial in addressing the challenges faced by territories in the context of disparities and territorial imbalances. This dimension is based on the principles of balanced territorial development and alignment between communities and infrastructure and it attempts to act against monocentric trends and encourage polycentrism (González et al., 2015).

This dimension requires special attention because polycentricity has two complementary aspects: one related to morphology (communities, population density, distribution, etc.), and the other to relations between communities (connectivity, infrastructures, flows, networks, cooperation, transport, etc.) (ESPON, 2015).

Based on these dimensions, territorial cohesion is perceived as being the ability of territories to promote balanced development, to reduce existing disparities and territorial imbalances, and to promote processes of economic and social cohesion, as well as environmental sustainability through good territorial governance. It is important to identify these dimensions, not only because they make it easier to clarify the meaning of the concept, but also because they allow each dimension to be combined with the most suitable components and indicators for measuring territorial cohesion.

2.2. Rail infrastructure – accessibility issues in the context of Territorial Cohesion

Transport infrastructure occupies a fundamental place in the regional development process because of its impact on territory accessibility. Moreover, it is an important tool for territorial cohesion and integration, acting as a catalyst in the process of uniting several multinational spaces.

Accessibility is the main 'product' of a transport system that determines the local advantage of an area (region, city) to all areas, including itself. Accessibility indicators measure the benefits of households and businesses in an area, as well as the existence and usage of transport infrastructure relevant to the respective area. Good accessibility to transport is certainly an important factor in exploiting the territories' potential. Aspects such as capacity, travel speed, or infrastructure connectivity influence the quality and advantage of a location over other locations, being considered as factors of accessibility (Vulevic, 2016).

The role of transport infrastructure accessibility within territorial development implies that areas with better access to the locations of economic goods and entry markets will be more productive, more competitive, and therefore more developed than remote and isolated areas (Vulevic, 2016, Manaeva & Kanishteva, 2017, Kozhevnikov, 2020).

In this respect, a considerable number of debates regarding the effects of accessibility on economic development have been conducted as the spatial distribution of accessibility is one of the variables used to measure the regional disparities. Also, equal access to services of general economic interest (in this case, transport services) is an essential condition for territorial cohesion. For this reason, the EU pays special attention to the regions struggling with problems regarding accessibility and integration. Accessibility is thus a key factor in achieving the European Union's cohesion objective, namely ensuring a fair distribution of accessibility in all its regions and reducing the existing accessibility disparities (Lopez, 2005).

Some analysts believe that the regional development policies that focused on the transport infrastructure in the underdeveloped regions have failed to reduce regional disparities between EU regions, while others stress that this aspect must be still analysed.

Concerning policy-making, maximizing accessibility is only an objective as far as it contributes to improving the quality of life, the access to opportunities, goods, and services, and participation in social and cultural life (ESPON, 2015).

Over the years, a significant number of studies on the issue of accessibility of transport infrastructure have been conducted and the subject continues to be approached (Dionelis,

Mourmouris & Giaoutzi, 2012, Vulevic, 2016, Christodoulou & Christidis, 2019, Vulevic et al. 2020).

Yanovskyy and Matiychyk (2014) analysed accessibility to transport infrastructure, relating to the tangible characteristics of infrastructure, such as its length. This approach suggested that the level of infrastructural development directly affects the accessibility of passenger transport. Based on two accessibility ratios, namely Engel and Goltz, the author analysed the accessibility of the central region of Ukraine to two types of transport- road and rail.

Also, other authors (Karras, 2010, Briceño-Garmendia, Moroz & Rozenberg, 2015) focused on the relationship between the accessibility of transport infrastructure and economic prosperity. Their studies revealed that investments in transport infrastructure can have both positive impact (population or gross product growth) and negative impact (the economic degradation of the region, as businesses and residents can migrate easier).

More than that, investments in transport infrastructure positively influence the economic growth of an area if three conditions are met: the investment increases accessibility in a region, transport is relevant to the processes of firms within the area and infrastructure does not generate negative externalities on the environment. These conditions are supported in ESPON's report on the accessibility of transport in Europe (2011), namely that accessibility is important because it provides access to opportunities in remote locations or makes it possible to receive goods, services, and visitors from remote locations.

Thompson and Taniguchi (2001) concluded that the development of transport infrastructure (increased accessibility) leads to an increase in the number of jobs and a decrease in the prices of goods. Generally, high accessibility resulted from investments in transport infrastructure is considered an important benefit for users (citizens) and businesses. A traveler can make a journey at a lower cost or a higher convenience; congestion could be avoided and more than one destination could be reached at the same time. For companies, a reduction in transport costs can increase production efficiency, competitiveness, and attractiveness Also, better transport conditions can improve the labor market and productivity (Geurs, Patuelli & Dentinho, 2016).

Recent studies have focused on High-Speed Rail (HSR) and its impact on accessibility and development (Cascetta et. al., 2020, Monzon, Lopez & Ortega, 2019). In Europe, in 2016, the HSR was 8100 km planned and it continues to grow (Cascetta, 2019). The development of HSR is studied in countries around the globe, such as Australia, Belgium, China, India, Italy, France, Spain, Turkey, United Kingdom, USA, emphasizing its effect on socio-economic development and transport service (Cascetta et al., 2020). In another study (Jiao, et. Al., 2020) authors observed that HSR contributes to economic growth because it improves the accessibility and connectivity in the railway network. Also, they conclude that the benefit of HSR on economic growth is mainly accomplished by its network spillovers rather than the isolated existence of HSR infrastructure.

Other authors (Sakamoto, 2012, Rokicki & Stepniak, 2018) approached the subject of transport infrastructure investments and regional development related to accessibility. They noticed that accessibility improvement seems to be weakly but positively correlated with growth in regional employment, with an insignificant impact on the growth of regional production.

However, the relationship between accessibility and territorial and economic development is not simple or easy to infer, as the effects are extremely complex and difficult to predict. For example, improved accessibility between two countries, cities, areas or regions can sometimes benefit one of them but disadvantage the other.

Also, increasing equity, accessibility, and promoting economic efficiency are often conflicting objectives (Geurs, Dentinho, and Patuelli, 2016, Ben-Elia & Benenson, 2019). As an example, providing all individuals and relevant population groups with a basic level of access by providing public transport services in remote areas and/or providing public transport subsidies to specific population groups (elderly, disabled, etc.) is often economically inefficient.

More than that, accessibility is not easy to quantify and there is no generally valid approach. Accessibility measurements have been used in the scientific literature to assess the performance of transport networks. Measurement of accessibility also plays a key role in

evaluating the competitive advantage of some locations due to the quality of transport infrastructure.

Handy and Niemeier (1997) classified the existing measures into three categories: isochronous (indicating the number/proportion of destinations accessible in a given journey, time/distance/cost from an origin), gravity-based measures (which involve gradual decrease inaccessibility as travel time to destinations increases) and utility-based measures (which estimate accessibility at the individual level).

Another classification was established by Geurs and Ritsema van Eck (2001) which suggested four basic perspectives: infrastructure-based measures, activity-based measures, people-based measures, and utility-based measures.

The relationship between transport infrastructure and territorial development has become more complex than ever. The concept of accessibility ranges from very simple indicators to sophisticated indicators that may differ in complexity:

- Simple accessibility indicators – take into account only the transport infrastructure in the area (e.g. the length of the railways, the number of railway stations).
- More complex accessibility indicators – take into consideration the connectivity of transport networks and distinguish between the network itself and the opportunities that can be accessed using transport infrastructure.

More complex accessibility indicators can be classified by destination and impedance factors (Schürmann et al., 1997):

- Cost indicators measure the total travel cost for a set of predefined destinations.
- Daily accessibility is based on the notion of a fixed timeframe that a person is willing to dedicate towards fulfilling a journey. Maximum travel times between three and five hours are frequently used for this type of indicator.
- Potential accessibility is based on the assumption that the attraction of a destination increases with size and decreases with distance, travel time, or cost. The size of the destination is usually represented by population or economic indicators, such as GDP or incomes.

Based on the three basic accessibility indicators, an almost unlimited variety of derived indicators can be developed.

3. An Inquiry into the Population Accessibility to Rail Transportation in Romania

3.1. Data and research methodology

The present research aims to examine Romanian railway infrastructure's influence on territorial cohesion through regions' accessibility to infrastructure and passenger rail transport services. As mentioned in the Introduction, Romania represents a relevant case study in this respect, given her strategic location on the EU map: she can be seen as a 'turntable' for passengers and goods flows between the West and the South-Est and thus the state of territorial cohesion in Romanian from the accessibility viewpoint can offer significant hints about the accomplishment of the overall European targets for this chapter.

Based on this purpose, the study's main objectives are:

O1: To identify regions' degree of accessibility to railway infrastructure in Romania using Engel and Goltz ratios.

O2: To identify the degree of accessibility to the existing railway infrastructure in the South-West Oltenia region using the Hansen accessibility coefficient, as well as the accessibility of Craiova city to other important economic centers from Romania. The choice of this region was based on its role for ensuring the connection of the South part of Romania (where Bucharest, the capital city is located) to the West region, a major gate to Westren Europe.

O3: To propose recommendations on improving accessibility to infrastructure and passenger rail transport services.

The research methodology consists of an exploratory study conducted using qualitative and quantitative approaches.

In accordance with the study's objectives, the calculation of the following indicators has been envisaged:

1. The Engel ratio: shows the rail transport network accessibility related to the population of a given area, the accessibility being computed according to the existing kilometers of railway within an area/region:

$$E = \frac{L}{\sqrt{S \cdot P}} \quad (1)$$

where:

L= the railway network length (km)

S= the total surface of the area/ region (km^2)

P= the population of the area/ region

2. The Goltz ratio: shows the accessibility of the transport network, related to all existing communities within an area:

$$R = \frac{L}{\sqrt{S \cdot N}} \quad (2)$$

where,

L= the length of the railway network (km)

S= the total surface of the area/ region (km^2)

P= the total number of the communities within the area/ region

3. The Hansen accessibility coefficient allows analyzing the degree of accessibility to railway transport, based on the characteristics of the rail transport service (distance, duration, cost of travel).

The Hansen index is the mathematical expression of the accessibility of a point of interest "j" relative to all points of origin "i" in a given space "S":

$$A_j = \sum_{i \in S} \frac{1}{f(x_{ij})} \quad (3)$$

where:

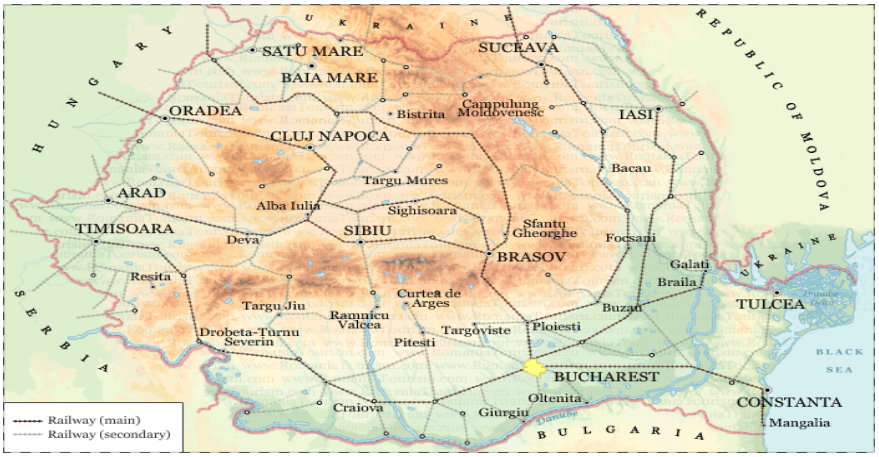
- $f(x_{ij})$ is the impedance function (the function of the difficulties encountered during a journey);
- x_{ij} is the variable of the impedance function, that can be expressed through:
- the distance traveled between the origin point "i" and the destination point "j"
- the travel time between the origin point "i" and the destination point "j"
- the cost of travel between the origin point "i" and the destination point "j"

These indicators proved their relevance in previous studies undertaken at international level (e.g. Yanovskyy & Matiychyk, 2014) given their composition, the application in the case of Romania is feasible as well. The necessary input data are annually provided by the National Institute of Statistics of Romania. In addition, data provided by CFR Travellers website (the website of the Romanian Railways – Passenger Section) have been used.

3.2. Results

The Romanian railway network is structured in interoperable and non-interoperable infrastructure. The interoperable railway infrastructure connects to the trans-European rail infrastructure, being managed in accordance with the provisions on open access for railway operators and developed following the technical rules for interoperability adopted at the European level. Non-interoperable rail infrastructure represents the local traffic-related infrastructure, whether or not connected to interoperable rail infrastructure, managed and developed based on specific internal regulations (CFR, 2020).

Image 1: The Romanian railway network map



Source: Romania Tourism, 2020

Table 1: The railway network length in the Romanian regions (2019)

Regions	Population	GDP/capita	Railway(km)
NORTH-WEST	2552112	44853,5	1663
CENTER	2318272	46658,7	1333
NORTH-EAST	3198564	30762,6	1614
SOUTH-EAST	2396171	40568,3	1745
SOUTH-MUNTENIA	2929832	38050,1	1247
BUCHAREST-ILFOV	2315173	111159,5	279
SOUTH-WEST OLTENIA	1926860	50144,4	990

Source: Authors, adapted by the National Institute of Statistics, 2020

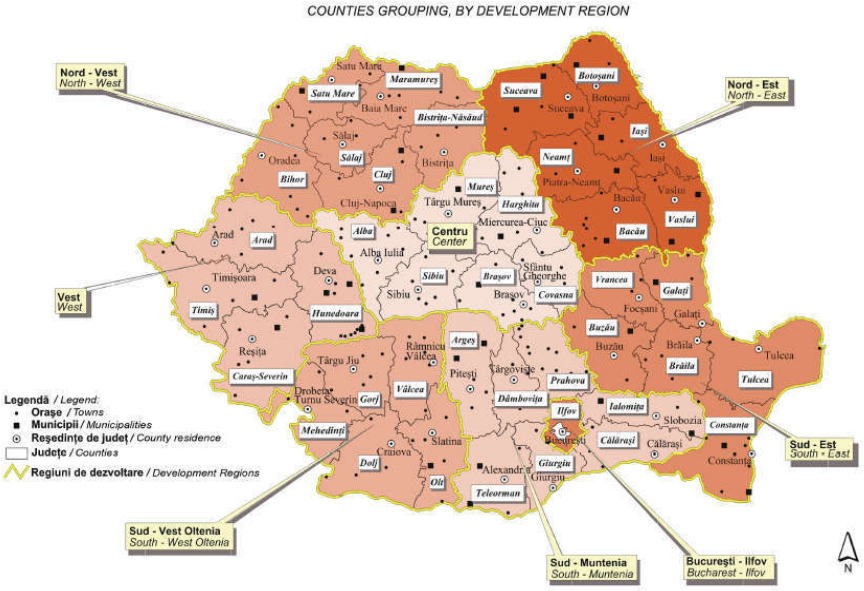
The railway network in Romania (Image 1) has a total length of 20,077 km of lines, making it the seventh-largest network in the European Union. The lines are connected by 20,070 equivalent switches. The network comprises 17,945 bridges and bridges, 176 tunnels, and 11,473 km earthworks (CFR, 2020). South-East region has the highest railway density (1745 km), followed by the North-West region (1663 km) and Bucharest-Ilfov, the lowest (279 km).

3.2.1. Accessibility at development region and county level

This section presents the results regarding the analysis of the population's accessibility to the rail transport infrastructure through several reports and accessibility indices.

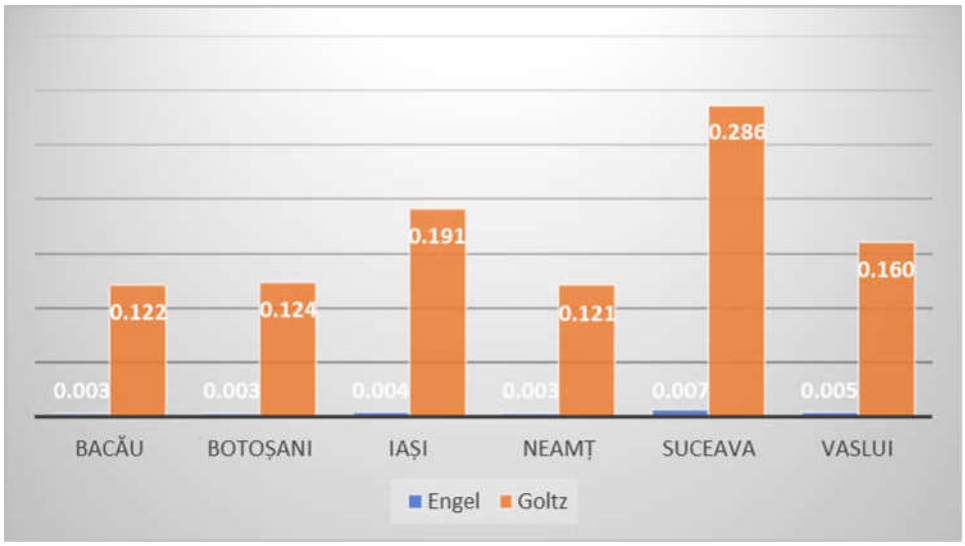
To investigate the degree of accessibility at the regional level, the Engel ratio, which shows the accessibility of the rail transport network related to the population of a given area, and the Goltz ratio, which shows the accessibility of the transport network in relation to all existing communities within an area, have been used. In both reports' cases, the accessibility is computed based on the existing rail network (kilometers) within an area/region. Both the NUTS2 (development regions) and NUTS3 (counties) levels have been considered. The territorial structure of Romania for these levels is presented in Image 2.

Image 2: The territorial structure in Romania – NUTS2 and NUTS3



Source: National Institute of Statistics

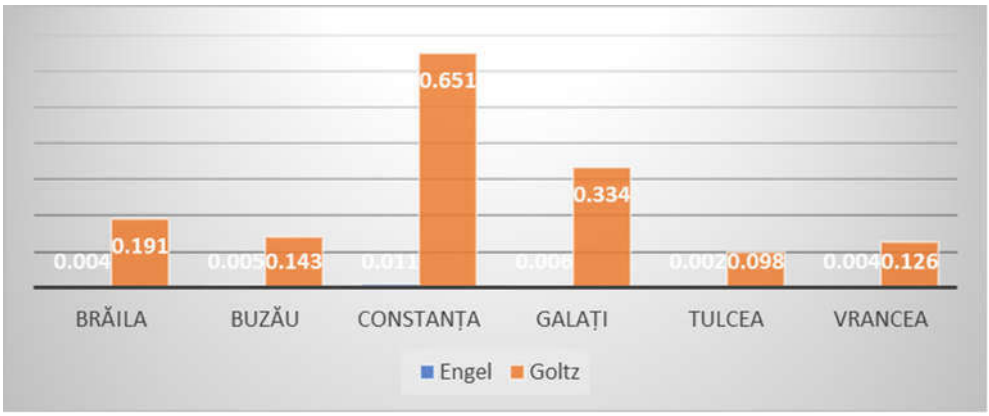
Figure 1: The accessibility of North-East Region



Source: Authors, based on the results of Engel and Goltz reports

Within the North-East region, the county with the highest degree of accessibility is Suceava, which registered the highest values for both reports. In this county, the railway infrastructure is more developed compared to the rest of the counties, Suceava having a total of 526 km of the railway network. Also, Iasi County registered high values in terms of Engel ratio, but lower values than Vaslui County. The result is explained by the fact that, although both counties have almost the same area, the infrastructure of Iasi County serves a population twice that of Vaslui County.

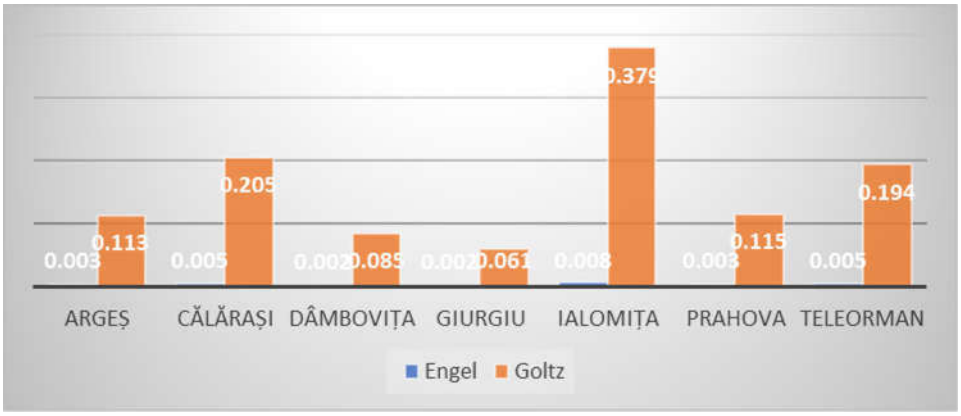
Figure 2: The accessibility of South East Region



Source: Authors, based on the results of Engel and Goltz ratios

Concerning the South-East region, the county with the greatest accessibility is Constanța, which posses a more developed railway infrastructure compared to the rest of the counties, which is also due to the presence of the port of Constanța. High accessibility of the population to the transport infrastructure was also revealed in the case of Galați County, followed by Brăila, Buzău, and Vrancea. The lowest accessibility, compared to the rest of the counties in the region was registered in Tulcea, the county where the Danube Delta is located.

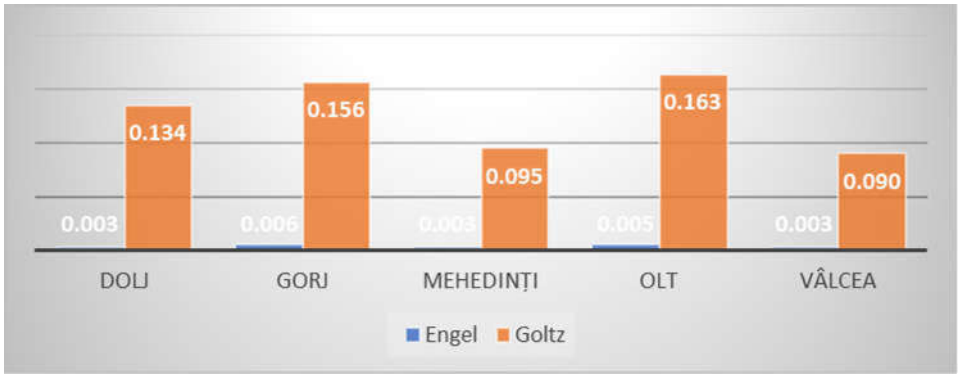
Figure 3: The accessibility of South-Muntenia Region



Source: Authors, based on the results of Engel and Goltz ratios

In the South-Muntenia region case, the county with the highest accessibility of both the population and the communities to the railway infrastructure is the Ialomița. Another county with high accessibility of the population to the railway infrastructure is Călărași which is followed by Teleorman, Prahova, Dâmbovița, and Giurgiu. This order remains in the Goltz ratio's too, indicating the accessibility of all existing communities within a region to the infrastructure that serves the analysed region.

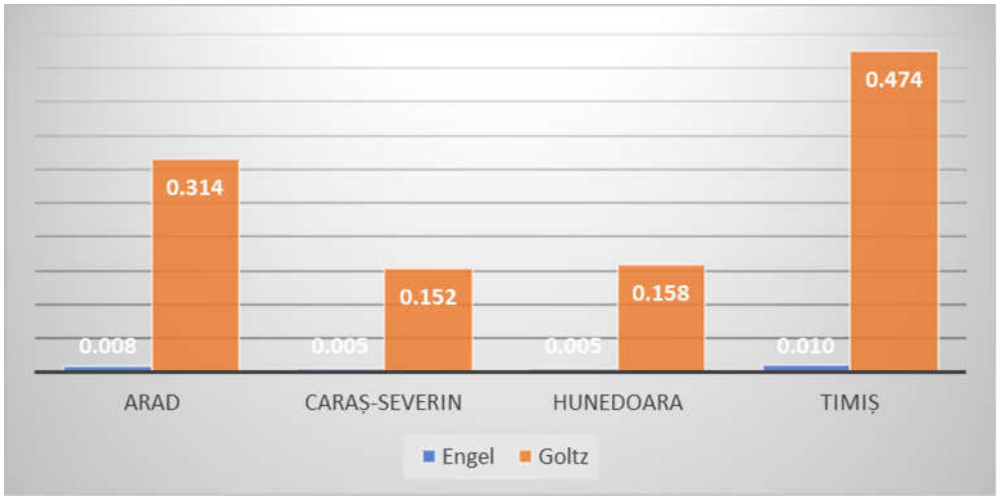
Figure 4: The accessibility of South-West Oltenia Region



Source: Authors, based on the results of Engel and Goltz ratios

Concerning the South-West Oltenia region, the counties with a high degree of accessibility are Olt and Gorj, which recorded the highest values. The difference between them is that, while the Olt has higher accessibility of communities to the railway infrastructure, Gorj register higher accessibility of the population. The rest of the counties presented similar values for the Engel ratio, but there are differences regarding communities' accessibility.

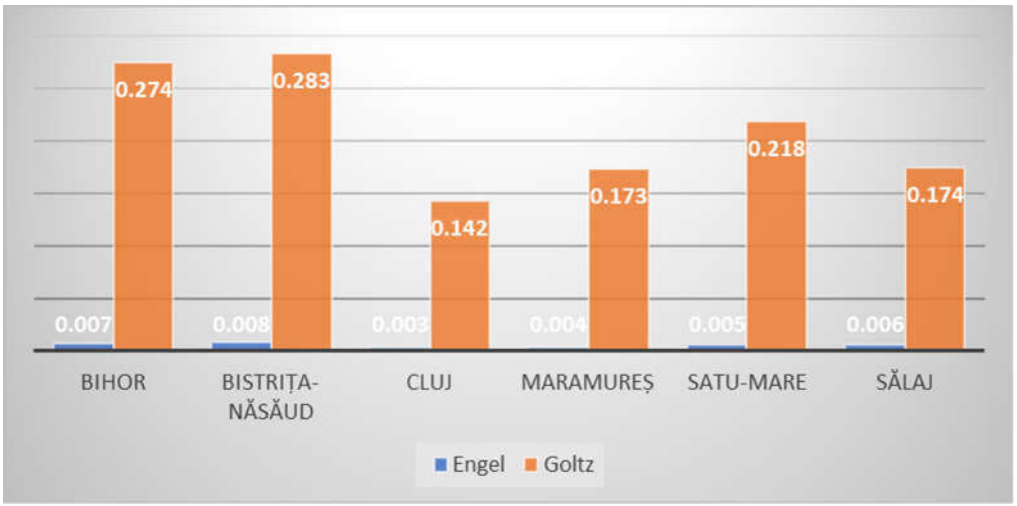
Figure 5: The accessibility of West Region



Source: Authors, based on the results of Engel and Goltz ratios

In the West region's case, the greatest accessibility to transport infrastructure was observed in the case of Timiș County, for the population as well as for communities. High values were also registered in Arad County for the two reports, followed by Hunedoara and Caraş-Severin, both areas presenting similar values.

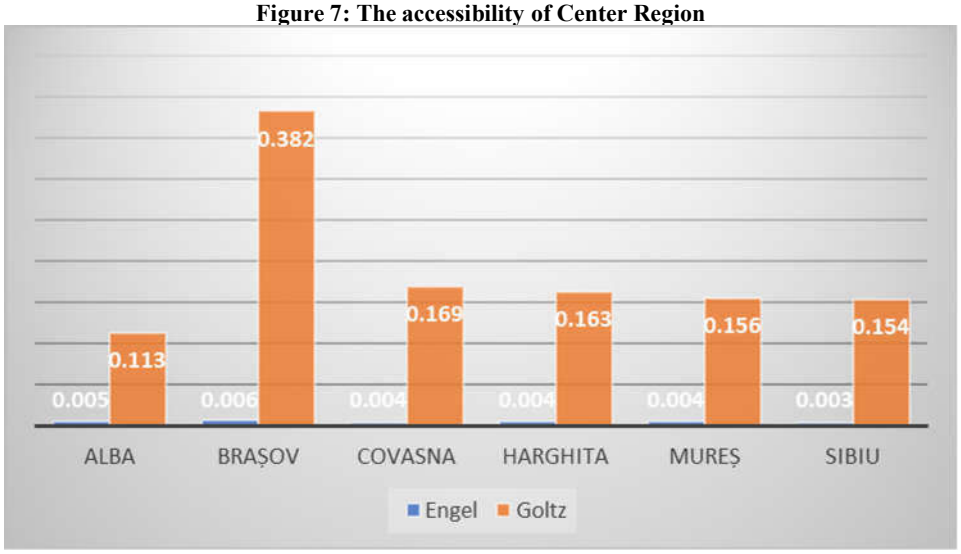
Figure 6: The accessibility of North-West Region



Source: Authors, based on the results of Engel and Goltz ratios

In the case of the North-West region, the counties with the highest accessibility of the population to the transport infrastructure were Bistrița-Năsăud and Bihor, which also presented the highest degree of accessibility for communities. Satu-Mare county also registered high accessibility for communities, but according to the outcome of the Engel ratio, it registered lower accessibility of the population compared to Sălaj County. Overall, the differences in accessibility are quite significant.

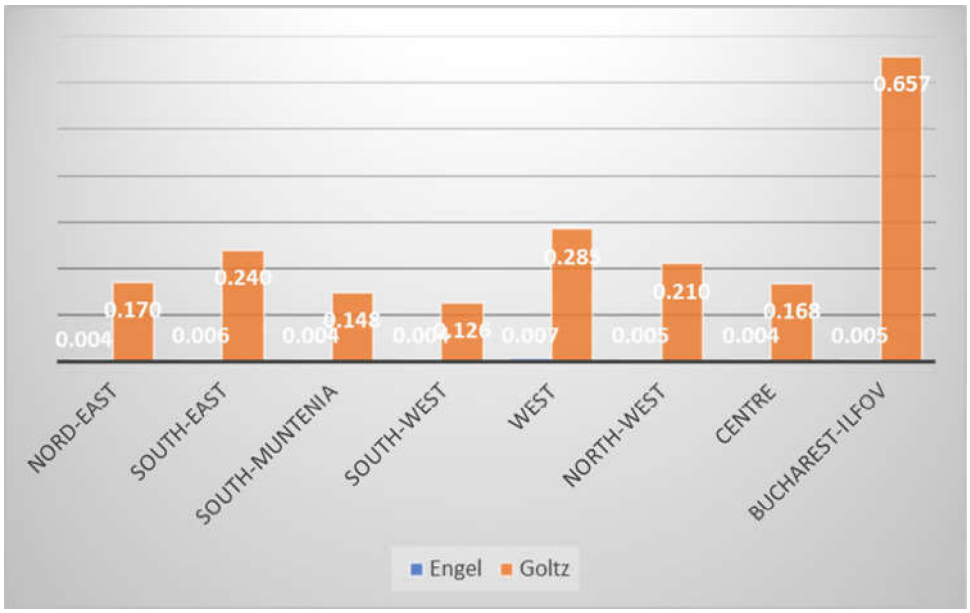
Figure 7: The accessibility of Center Region



Source: Authors, based on the results of Engel and Goltz ratios

In the Center region's case, the highest degree of accessibility from both population and communities was registered in Braşov county. Covasna, Harghita, and Mureş counties registered similar population accessibility and minor differences regarding communities' accessibility. Although Alba County presented the lowest accessibility of communities, in its case a higher level of accessibility of the population was observed, compared to the aforementioned counties.

Figure 8: Romanian regions' accessibility



Source: Authors, based on the results of Engel and Goltz ratios

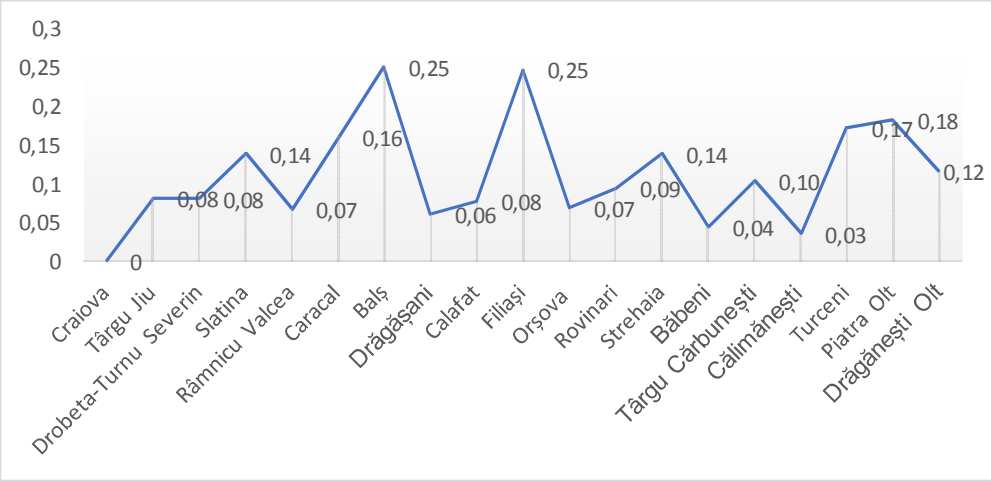
Overall, the region with the highest degree of accessibility is the West region, without considering Bucharest-Ilfov. In this analysis, the Bucharest-Ilfov region was not analysed because it represents a special case related to its small surface and a very high number of citizens compared to the rest of the regions. At the same time, given Bucharest's status of capital city, it is by far the most important railway node in the country.

As regards the situation of accessibility to transport infrastructure, it can be affirmed that there are differences both at regions' level and in their administrative components (counties), the intensity of these differences varying from case to case. In most cases, greater accessibility was registered in the counties which represent important economic centers or transport hubs.

3.2.2. Spotlight on South-West Oltenia development region

Within this section, using the Hansen accessibility index, the degree of accessibility within the South-West Oltenia region will be analysed to identify the accessibility of the main cities of the county towards Craiova economic center based on the traveled distance, the costs, and the necessary time of a train journey. The processed data were gathered from the CFR Travellers website (Romanian national railway company). There have been taken into consideration especially the direct trains, and in the cases where there were no direct trains, the trains involving several exchanges have been taken into account. Regarding the significance of the Hansen report, the high results showed high accessibility of the chosen city compared to Craiova.

Figure 9: South-West Oltenia cities' accessibility



Source: Authors, based on Hansen index

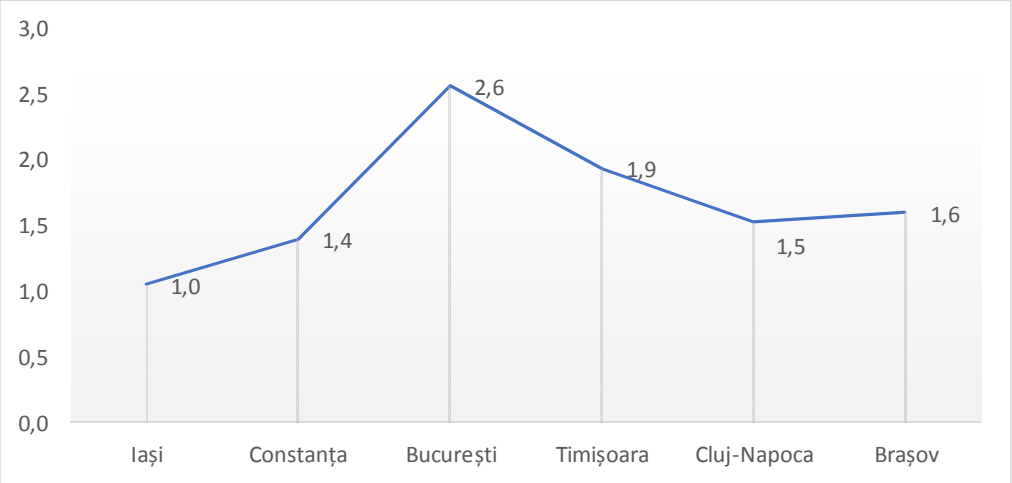
The analysis results reveal that the towns and cities from South-West Oltenia region can be grouped into 3 categories: cities with high accessibility, such as Balş and Filiaşi, cities with average accessibility, such as Slatina, Caracal, Strehaia, Targu Carbunesti, Turceni, Piatra Olt and Drăganesti-Olt and cities with low accessibility, such as Târgu Jiu, Drobeta-Turnu Severin, Râmnicu Vâlcea, Drăgăşani, Calafat, Orşova, Rovinari, Băbeni and Călimăneşti.

Considering these results, it can be stated that the variable with the highest influence within the Hansen index is the distance. An indirectly proportional relationship between the traveled distance and the degree of accessibility was observed: if the distance to be traveled increases, the degree of accessibility decreases. At the same time, long-distance also results in a higher period of time necessary for traveling.

More than that, one can affirm that the accessibility of these towns and cities follows one of the trends described by Handy and Niemeier (1997), namely that the accessibility decreases as the distance increases. This relationship determines the presence of a center-periphery pattern because the cities near Craiova (Balş and Filiaşi) present higher accessibility, the degree of accessibility diminishing the further away we moved from the chosen economic centers.

Using the Hansen index, the accessibility of Craiova compared to other economic centers from Romania by rail transport was analysed. As in the previous part of the analysis, the processed data was gathered from the CFR Travellers website, taking into account, in particular, direct trains. In the absence of these, trains involving several shifts have also been selected.

Figure 10: The accessibility of Craiova city



Source: Authors, based on Hansen index

The results reveal that, concerning rail transport, the accessibility of Craiova compared to other economic centers differs depending on the city chosen as the destination. Thus, Craiova has high accessibility compared to Bucharest and Timisoara and average accessibility compared to Constanta, Cluj Napoca, and Braşov. Regarding Craiova's accessibility to the city of Iasi, the lowest value is recorded because the analysed variables registered the highest values compared to the rest of the cities. Also, in this case, a similar pattern similar to the one described above was observed: the long distance to travel leads to a longer journey time, consequently, the accessibility lowers. Another influencing factor is the frequency of direct trains, more trains running on the Craiova-Bucharest route.

4. Concluding remarks and recommendations

The rail transport infrastructure is a basic element within a territory, influencing economic growth and reducing regional disparities by improving regions' competitiveness. In this respect, the present research explored the manner in which the Romanian railway infrastructure influences territorial cohesion through regions' accessibility to infrastructure and passenger rail transport services.

In order to achieve an overview regarding the accessibility of Romanian regions to transport infrastructure, the Engel and Goltz ratios were used for computing the accessibility to the infrastructure according to its length and the covered area, population, and the total number of communities within a region. The results revealed the presence of differences in accessibility at both the regional and county level.

The analysed data showed that, without considering Bucharest-Ilfov region, the West region presents the highest degree of accessibility.

Further on, lowering the observation scale, by analysing the accessibility of a region's cities related to its main economic center, it can be noticed that these cities' accessibility presents a center-periphery pattern: with the increase of the distance between the chosen city and the economic center, the accessibility decreases.

In view of the results outlined above, it cannot be affirmed that the Romanian railway infrastructure contributes to reducing disparities and strengthening territorial cohesion. Although it is sufficiently extensive, it has uneven growth and low accessibility due to low travel speeds and long travel times. Regarding accessibility, it should be mentioned the presence of at least two types of disparities - interregional and intra-regional, due to the fact that disparities in accessibility firstly manifest at the regional level and increase in intensity at the county level.

The potential of the Romanian railway infrastructure is extremely high and, as a consequence, in order to have a positive impact on reducing disparities and strengthening territorial cohesion several policy actions are necessary, the ones recommended below included:

1. Better usage of the European funding allocated for railway infrastructure.

The railway infrastructure in Romania requires the allocation of higher amounts of funds to increase its competitiveness, amounts that cannot be fully supported by the state's budget. Future investments should focus exclusively on the rehabilitation and modernization of railways and the existing rolling stock in operation, to allow for high travel speeds and a higher degree of comfort.

2. Joint partnerships between railway managers and local actors or administrative authorities. In most cases, the accessibility of the population to the railway transport infrastructure is influenced not only by factors related to it and its degree of development but also by aspects related to the level of development of the area from which users come.

For example, in some communities' case, there is no means of transport to provide the population with access to railway stations. In addition, higher accessibility cannot be achieved only by developing railways no matter how many resources are invested in them. It is, therefore, necessary to rehabilitate the access routes to the railway stations, as well as to rehabilitate these stations, but this cannot be done without the involvement of the local authorities.

3. Adapting transport schedules according to user needs and requirements. Reaching a higher degree of accessibility and attractiveness for rail transport can also be obtained by changing existing transport schedules. In order to be able to identify these needs or requirements, questionnaires could be distributed to passengers when boarding the trains.

4. Attracting and training human resources. One major problem that will be increasingly wide is the lack of railway staff such as mechanics and aid mechanics. The lack of attractiveness of the railway sector, the low level of development of infrastructure and rolling stock, as well as existing working conditions are the main factors determining the decreasing number of young people choosing a career in this field.

5. Increasing the presence of private operators and supporting a healthy competitive environment. The presence of private operators on as many routes as possible could lead to increased accessibility as well as increased efficiency and quality.

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