THE EVOLUTION OF RAILWAY TRANSPORT INFRASTRUCTURE IN ROMANIA AFTER 1990

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Abstract: *The purpose of this paper is to analyse the physical, economical, and strategic evolution of the Romanian railway infrastructure based on data extracted from EUROSTAT. The timeframe chosen for this study is between years 1990 and 2019, from the fall of the communist regime, through 2007 when Romania became a member of the European Union, until the beginning of the Covid - 19 pandemic. The Romanian railway infrastructure is analysed and compared with those from other European countries. One of the first observations is that the Romanian railway has one of the largest networks in Europe, being placed 2nd in terms of length in year 1990, after Poland. Unfortunately, in contrast to having one of the largest networks, economically it situated at the end of the hierarchy, being one of the most inefficient. Having constant decreasing amounts of transported goods over time, the sector doesn't have enough cash flow to secure the necessary funds for maintenance and mandatory technological upgrades. The sector is badly managed and cannot sustain itself anymore. The high number of victims each year makes it one of Europe's most unsafe railway networks and this hinders the level of trust and willingness for collaboration from private entrepreneurs. The private sector should be encouraged to increase the volume of goods transported as well as participate in investments. The Government could even consider a Public Private Partnership strategy to attract a cash infusion into the sector. There is great potential for a positive impact on the country's economy if the Authorities would implement a strategic investment and development master plan to bring the railway infrastructure to a level of reliability that would attract businesses and stimulate the movement of goods. The geographical location of Romania could accelerate such development since it could be an important logistics hub linking the Black Sea to the Central European market. Empirical results show that the length of railway network is negatively correlated with income and negatively associated with the volume of transported goods in Romania over the period of 2004-2019. It is apparent that for this sector the size of the current network should be sufficient, but quality should be improved, since this is the element that enhances operation safety and operation characteristics such as speed and volumes of goods transported. The paper includes recommendations for public policies regarding the transport infrastructure sector.*
Keywords: Romania; transport infrastructure; economic development; railway network; transport policies.

JEL classification: F63; F68; L92

1. Introduction

The economy of Romania has certain pillars with a central significance. One of these pillars is transport infrastructure. Through the years, the focus was on sustainable development of the road network through more efficient roads, such as the construction of highways. However, the railway infrastructure could, and still can, play a key role in the development of the national economy.

We analysed data about the railway network to show the development and investment trends in transportation infrastructure of a country emerging from the communist regime and going through the transition of becoming a democratic Member State of the European Union (EU). This transition opened the market and facilitated investment and trade, but it also gave access to massive financial support through the European Cohesion Funds. It has been previously showed by other Romanian researchers that the absorption of such funds has been very low and that there is a big difference between what the Romanian Authorities have planned before the year 2007 and what they have done after said year (Popescu & Fistung, 2014).

The aim of this paper is to analyse the evolution of the railway transport infrastructure in Romania in the past 33 years, based on statistical data from EUROSTAT, and to make some policy recommendations. The paper intends also to show the correlation between the railway transport infrastructure and the movement of goods and economic development of Romania.

After revealing the importance of transport infrastructure in the economy, based on existing literature, the third section shows the evolution of the railway network over time, and the current percentage of electrified tracks. This is to show evolution in time but also the efficiency, as well as the level of concern for environmental protection in past policies. We also present the traffic management system and the safety levels of the network, with a brief comparison with other European countries. The evolution of the human resource strategy is also discussed during the transition from the communist to the capitalist approach.

The fourth section presents the research methodology, being followed by empirical results. In the final part we showed our conclusions regarding our findings and made some policy recommendations.

2. The Importance of Transport Infrastructure for the Economy

We chose to analyse the transport infrastructure data because it acts as the backbone of economic activities, and it can facilitate the movement of goods and labour force supporting economic growth and development. It encourages private investments and stimulates business to engage in trade by enhancing the mobility of people allowing them access to higher education, better health services and access to jobs that are further away from their home. Previous research such as the work of Herranz-Loncan (2007) has revealed a positive correlation between infrastructure investments and economic growth.

The importance of transport investments and policy in the economy has been extensively debated and studied (Aschauer, 1989; Easterly & Rebelo, 1993). Investments in infrastructure development have been a focus throughout history

allowing us to observe cases such as that of the Swedish infrastructure development. In the first phase of their industrialisation period in the 1850s they focused on infrastructure construction. Only after the Second World War did they focus more on education to infuse the industry with well trained and specialised labour force. Policy making is a complex process and it must not be left only in the hands of politicians, but it should be a common effort of decision makers and specialists who analyse several competing models or scenarios (Eliasson et al., 1993).

A well-managed transport infrastructure can attract foreign investment and the case of Romania could be a good example of such approach since it emerges from a closed economy and it opened to the international market. Foreign direct investment has been shown to positively influence the logistics infrastructure and lead to economic growth in the recipient country. Even so, it comes to the responsibility of the recipient country to create the proper environment to attract such foreign investment by adjusting their policies and regulations (Saidi et al., 2020).

Optimisation of the environment is the key to make things work; some approaches can be optimistic in theory but might be hindered in practice by factors such as corruption. Thus, a country can dispose of optimal transport policies and development strategies but an unstable political administration with a general affliction towards bribery can distort the results of a 'master plan'(Cieslik & Goczek, 2017).

It is largely debated if investments in transport infrastructure lead to economic growth or if it creates economic competitiveness, but it is likely to happen under certain conditions, depending on the investment and development strategies, on transport and economic policies and on the political and institutional climate (Meersman and Nazemzadeh, 2015).

Transport infrastructure investments can also produce wider economic impacts that should be taken into consideration by the decision makers when choosing certain investment approaches or elaborating transport policies. Transport infrastructure usually implies large projects that tend to have large impacts on the economy both locally or at a regional level and in the case of railways the ripples of its effect could be felt on a national or international level (Rothengatter, 2017).

3. Evolution of the Romanian Railway Industry

3.1. Railway Network, Safety, and Transport Management Systems

In this paper, we chose to focus on the evolution of different sectors regarding the railway infrastructure from 1990 to 2019 and in some cases, we focused on the year 2007 for reasons that we shall further explain. Data regarding Romanian transport infrastructure has openly become available and started to be recorded on EUROSTAT only after the fall of the communist era. It was in 2007 when Romania became member of the EU, and 2019 is the last year with available data. Thus, our timeframe for this paper has been defined with focus on the years that we believe represent certain turning points in the development of Romania.

The first data analysed is the length of the railway network with focus on those countries that had recorded values for the timeframe selected. Due to the lack of data for certain countries we made two graphical representations: Figure 1 to show the evolution of total length of track from 1990 to 2007 and Figure 2 to show available data from 2007 to 2019. In 1990 Romania had a total of 22.179 km of railway tracks

and in the following 17 years until it became a EU Member State, the length of the railway network reduced by 1.511km. After year 2007, it further reduced by another 589 km even though this is a period when Romania started having access to the Cohesion Funds, including support specially designated for large infrastructure. We shall later show why this reduction in length is not as big of an issue as we might think, while showing the actual strategic mistakes that were made in these years. Romania has one of the largest railway infrastructures in Europe but also has one of the largest decreases in total length of railway network (EUROSTAT, 2021a).

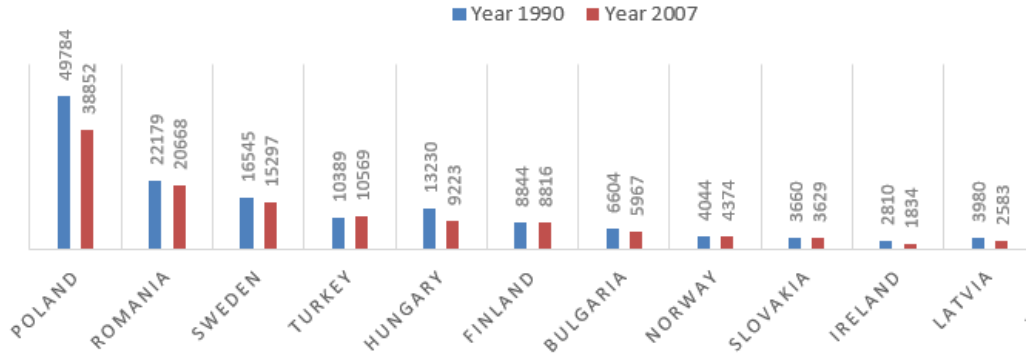

Figure 1: Evolution of length of tracks (km) in some European countries from 1990 to 2007
Source: Authors' own computation based on EUROSTAT data (RAIL_IF_TRACKS)

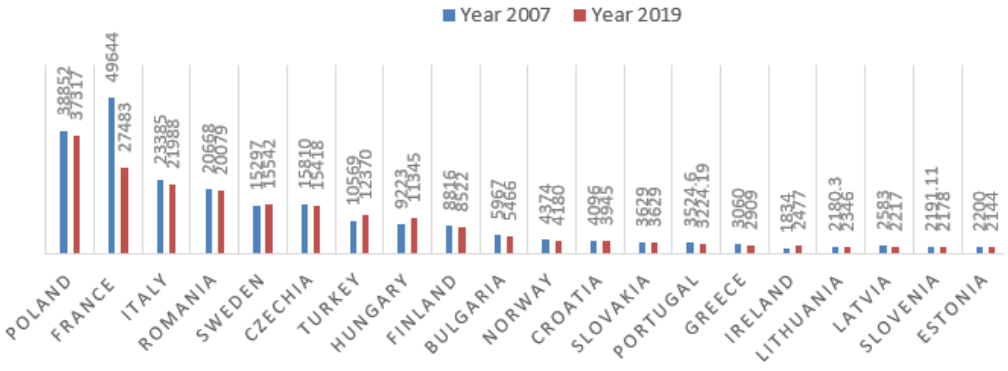

Figure 2: Evolution of length of tracks (km) in some European countries from 2007 to 2019
Source: Authors' own computation based on EUROSTAT data (RAIL_IF_TRACKS)

We must ignore the spike in France's total network length in the year 2007, observable in Figure 2, since it is explained in the metadata that a different type of measurement was used to obtain that value. In 1990, Romania was positioned 2nd in Europe, in terms of total length of railway network. In 2007 as more data have been recorded, the statistics expanded to 25 European countries, Romania being

the 5th. It was overtaken by Italy, France and Germany who are historically powerful economies and have extensive transport infrastructure, not to mention that all these countries, especially France, expand on much larger geographical areas. We can assume that extensive infrastructure building has been done during the communist era after that it was not a necessity to expand the network further. Meanwhile, we must argue that it would have been indeed a necessity for the State to invest in maintenance, refurbishments, modernisation and innovation (EUROSTAT, 2021a).

In Table 1 we observe the evolution of electrified railway lines in European countries. We computed the percentages of increase to compare the electrification process in different countries. On most of the 20.079 km of Romanian railway, unfortunately operators still use diesel powered locomotives, in an era in which one of the most emphasised phenomena is environmental protection (EUROSTAT, 2021b).

The total length of Romanian electrified railway tracks in the year 2019 is 4.029 km, representing 20.06% of the total network. We compare this value with the one from 1990, which is 3.680km to conclude that 349 km of railway tracks were electrified in a 29-year time frame. This represents an increase of only 9.48% in three decades. If we rank the countries percentage-wise then Romania is positioned 18th and if we rank them in terms of kilometres electrified then Romania is ranked 13th, either way it is ranked towards the end of the list which is a sign that investments in modernisation of the railway system have not been at its peak (EUROSTAT, 2021 b) (RAIL_IF_ELECTRI, 30/04/2021).

Table 1: Length of electrified tracks in 1990 and 2019 in some European countries

Country	Length of electrified tracks in 1990 (km)	Length of electrified tracks in 2007 (km)	Length of electrified tracks in 2019 (km)	Increase in electrified tracks (%)
France	12.512	15.123	16.067	28.41%
Italy	-	11.531	12.016	4.2%(d)
Poland	11.387	11.898	11.202	-1.62%
Spain	6.416	8.095	9.984	55.61%
Sweden	7.382	7.848	8.185	10.87%
Hungary	2.249	2.738	5.560	147.22%
Turkey	603	1.920	5.070	740.79%
Romania	3.680	3.959	4.029	9.48%
Austria	3.246	3.847	3.976	22.48%
Finland	1.663	3.047	3.331	100.3%
Czech R.	2.579	3.060	3.231	25.28%
Bulgaria	2.640	2.806	2.869	8.67%
Norway	2.426	2.552	2.483	2.34%
Portugal	458	1.435,6	1.695,65	270.22%
Slovakia	1.330	1.578	1.587	19.32%
Croatia	844	980	970	14.92%
Greece	-	199	731	72.77%(d)
Denmark	230	640	730	217.39%
Slovenia	499	502,75	610	22.24%

Luxembourg	197	262	262	32.99%
Latvia	271	257	250,9	-7.41%
Macedonia	233	234	234	0.42%
Ireland	37	108	158	327.02%
Lithuania	122	122	152	24.59%
Estonia	132	132	138	4.54%

Note: Percentages are calculated for the difference from 1990 and 2019
Source: Authors' own computation based on EUROSTA data (RAIL_IF_ELECTRI)

Safety is at the core focus of railway transportation since previous accidents have shown trains can produce catastrophes with massive human casualties and environmental damage, thus we shall extend our analysis to the data referring to traffic management systems and to victims in railway-related accidents.

In 2019, in terms of Track-Based railway traffic management, Romania is ranked 9th out of the 12 European countries with recorded data in this sector, being surpassed by countries with smaller railway networks like Bulgaria, Belgium and Slovenia, as shown in Figure 3 (EUROSTAT 2021c).

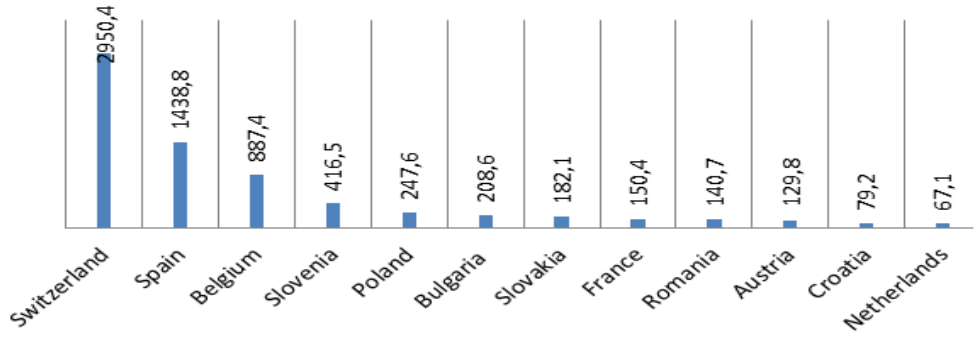

Figure 3: Length of tracks with track-based traffic management system (km) in 2020
Source: Author's own computation based on EUROSTAT data (RAIL_IF_TRAFF)

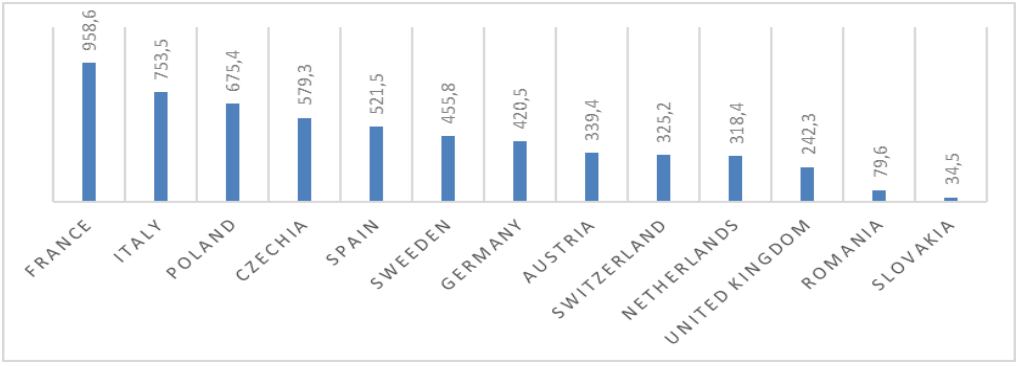

Figure 4: Length of tracks with radio-signal traffic management system (km) in 2020
Source: Authors' own computation based on EUROSTAT data (RAIL_IF_TRAFF)

From the perspective of Radio-Signal traffic management, Romania is second to last being furthermore surpassed by Netherlands, Austria, and other countries as seen in Figure 4, thus, placing Romania at the end of the European rankings in terms of traffic management systems. The reporting accuracy must be taken into consideration and the fact that other safety systems might be in place, systems that are not monitored on the European Statistics Platform. Even so, considering what we have learned based on available data and observing the lack of such technology in operation in Romania, we look at the number of victims in railway-related accidents (EUROSTAT, 2021 c).

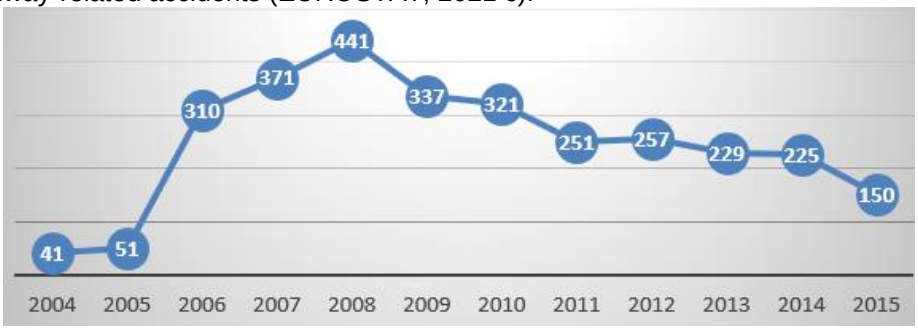

Figure 5: Number of victims in railway related accidents in Romania 2004-2015
Source: Author's own computation based on EUROSTAT data (RAIL_AC_CATVICT)

Figure 6: Distribution of victims in railway related accidents in Romania 2004-2015
Source: Authors' own computation based on EUROSTAT data

This data has been recorded from 2004 to 2015 and throughout these years Romania ranked amongst the first places in terms of number of victims. In 2007, when Romania become a EU Member State, prior to any external financial aid, it was ranked 3rd with a total of 371 victims. In 2015, 8 years after being granted access to various cohesion funds, thus having already the possibility of making certain investments to improve the safety systems, Romania is still ranked 3rd. The number of victims has reduced but almost half of the victims suffer fatal injuries, as portrayed in Figure 6 This shows that the Romanian Railways are amongst the most dangerous in the European Union (EUROSTAT, 2021d).

3.2 The Employment, Investments, and Transported Goods

It is popularly known in Romania that during the communist administration many people were employed by the Romanian National Railways, but it is impressive to see the data in Figure 7.

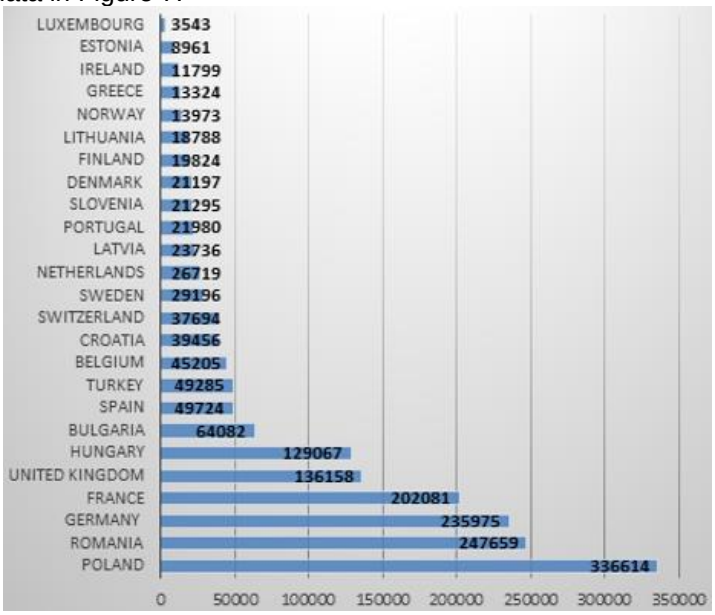

Figure 7: Number of employees in Railway Companies in European countries in 1990

Source: Author's own computation based on EUROSTAT data (RAIL_EC_EMPLO_A)

In 1990, 247.659 people were working for this company. This number represents 1.06% of Romania's total population in that year. This number placed Romania 2nd in the European rankings, having more railway workers than Germany, France, or the United Kingdom, having 5 times more workers than Spain, Turkey, Belgium or Croatia and even more than the last 13 countries combined (EUROSTAT, 2021e).

Figure 8 shows the employment in railway enterprises in Europe in 2008. In Romania there are 41.520 employees, a reduction of more than 200.000 jobs over 18 years. This massive reduction shows a more economic approach to the management rather than the social one before 1990.

The lack of expansion of the railway infrastructure makes us shift our focus to the available data on maintenance expenditure and investments. We can already conclude, based on previously analysed data that if investments did exist, these were not focused on electrifying tracks or on implementing new safety management systems.

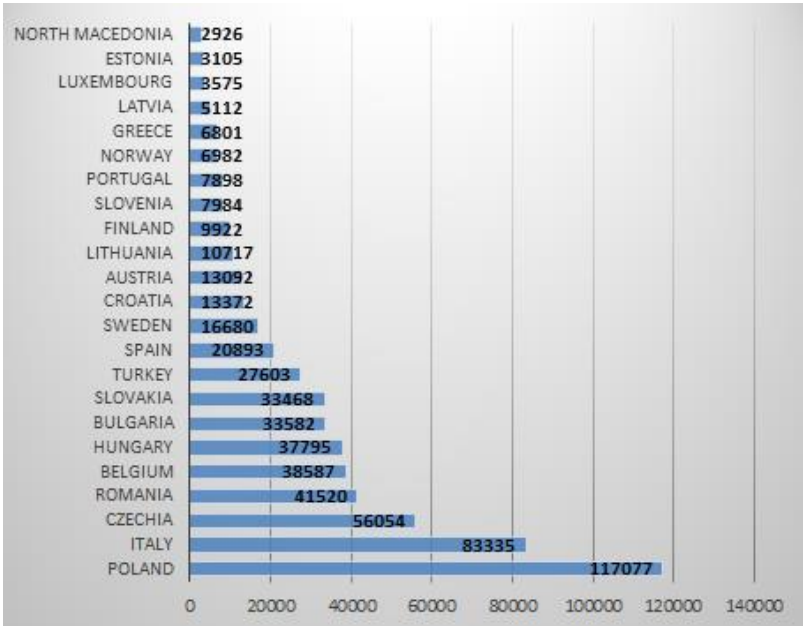

Figure 8: Number of employees in Railway Companies in European countries in 2008
Source: Authors' own computation based on EUROSTAT data (RAIL_EC_EMPLO_A)

Data regarding expenditures on maintenance is not available so we cannot do an analysis on this topic. The limited data and all values recorded add up to 13.8 million Euro with its peak in the 2004 with a value of 6 million Euro spent on railway infrastructure maintenance. The situation is similar with investments, all values recorded add up to 2 million Euro and they cover only 10 years. The lack of data leaves room for further additions to the research (EUROSTAT 2021f).

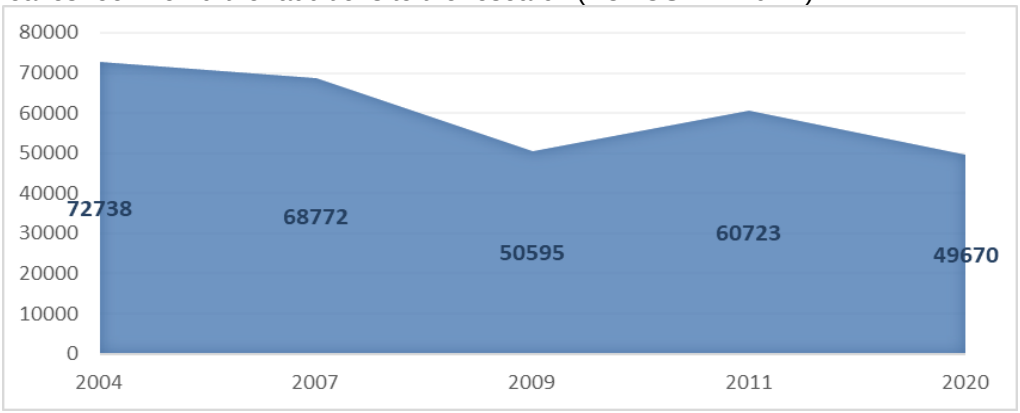

Figure 9: Goods transported by railway in Romania (thousand tons) from 2004 to 2020
Source: Authors' own computation based on EUROSTAT data (RAIL_GO_TOTAL)

One of the most important data to analyse is the transportation of goods. Data is available beginning with year 2004, so it does not cover the whole timeframe we established for this paper, but it is enough to observe the tendencies. In the year 2004 a total of 72.7 million tons of goods were transported by railway, this amount decreased through 2007, to 68.7 million tons but, the numbers were expected to rise in the years to come due to becoming a Member State of the EU. In reality, the volumes of transported of goods has stabilised at around 55 million tons per year for the decade to come only to reach its lowest point ever recorded in 2020, namely 49 million tons. Overall, we see a decrease in the transport of goods on the Romanian railway of more than 31% in the past 14 years (EUROSTAT 2021g).

4. Research methodology

One aim of this paper is to analyse the correlation between Romanian railway transport infrastructure and the movement of goods to determine if it influences the country's economic growth and the economic competitiveness. For this purpose, the following research hypothesis was formulated:
"The length of the railway has a positive and significant influence on the movement of goods in Romania".

The second research hypothesis is
"The length of the railway has a positive and significant influence over Romania's GDP".

Following these research hypotheses, the dependent variable is represented by the amount of goods transported using railways, respectively the GDP and the explanatory variable is considered the number of kilometres of railways. The data used was retrieved from the Eurostat database for the period 2004 – 2019.

We use the following regression model:

$$Y_t = \alpha + \beta \cdot X_t + \varepsilon_t \quad (1)$$

where: Y_t is the dependent variable, *t*-denotes time, X_t is the explanatory variable, α is a constant, β is the regression parameter, and ε_t is the error.

We will estimate two equations, one for each of the two dependent variables (GOODS and GDP):

$$GOODS_t = A_1 + A_2 \cdot LENGTH_t + \varepsilon_t \quad (2a)$$

$$GDP_t = B_1 + B_2 \cdot LENGTH_t + \varepsilon_t \quad (2b)$$

where: GOODS represent the goods transported using railways, GDP expresses the gross domestic product and LENGTH represent the kilometres of railways.

Data processing was made through E-Views software, using the Least Square method of estimation.

5. Empirical Results

The descriptive statistics of the variables shows by the Jarque-Bera test the abnormal distribution of them (p > 5%), with a positive skewness (Skewness > 0),

but a platykurtic kurtosis of movements of goods and GDP (Kurtosis < 3), and a leptokurtic kurtosis of railway length (Kurtosis > 3) (Table 2).

Tabel 2. Descriptive statistics of variables

	GOODS	GDP	LENGTH
Mean	59065.31	141646.7	20434.56
Median	55919.00	138200.8	20262.50
Maximum	72738.00	223162.5	21360.00
Minimum	50348.00	60402.00	20077.00
Std. Dev.	7631.593	42707.27	400.9178
Skewness	0.501301	0.033518	1.170769
Kurtosis	1.770533	2.734147	3.337151
Jarque-Bera	1.677867	0.050114	3.730983
Probability	0.432171	0.975254	0.154820
Sum	945045.0	2266347.	326953.0
Sum Sq. Dev.	8.74E+08	2.74E+10	2411026.
Observations	16	16	16

Source: Authors own computation based on data published by Eurostat (RAIL_GO_TOTAL, NAMA_10_GDP, RAIL_IF_TRACKS)

The results of the first regression equation reflect that there is a positive correlation between the length of the railway and the amount of goods transported (A2 = 14.26868). The length of the railway is a significant explanatory factor of the movement of goods in Romania, p-value being less than 1% (Table 3). According to this result, the research hypothesis was confirmed.

Table 3. Empirical results of first regression equation regarding the influence of the length of railway over the transportation of goods

Dependent Variable: GOODS; Included observations: 16
Method: Least Squares (Gauss-Newton / Marquardt steps)

	Coefficient	Std. Error	t-Statistic	Prob.
A(1)	-232508.9	68822.98	-3.378361	0.0045
A(2)	14.26868	3.367362	4.237346	0.0008

R-squared	0.561885	Mean dependent var	59065.31
Adjusted R-squared	0.530591	S.D. dependent var	7631.593
S.E. of regression	5228.664	Akaike info criterion	20.07817
Sum squared resid	3.83E+08	Schwarz criterion	20.17474
Log likelihood	-158.6253	HannanQuinn criter.	20.08311
F-statistic	17.95510	Durbin-Watson stat	1.539755
Prob(F-statistic)	0.000828		

Source: Authors own computation based on data from Eurostat (RAIL_GO_TOTAL, RAIL_IF_TRACKS)

The results of the second regression equation show the negative correlation between the length of the railway and GDP (B2 = -87.91613), the length of the railway being a significant explanatory factor of it (p-value < 1%) (Table 4). This result reflects the direct influence of railway infrastructure on the economic development of Romania showing the unsustainability of the Romanian infrastructure and the lack of investments that inhibit economic growth. Based on the result obtained, the research hypothesis was invalidated.

Table 4. Empirical results of second regression equation regarding the influence of the length of railway over the GDP

Dependent Variable: GDP
Method: Least Squares (Gauss-Newton / Marquardt steps)
Included observations: 16

	Coefficient	Std. Error	t-Statistic	Prob.
B(1)	1938174.	328562.5	5.898952	0.0000
B(2)	-87.91613	16.07586	-5.468828	0.0001

R-squared	0.681152	Mean dependent var	141646.7
Adjusted R-squared	0.658377	S.D. dependent var	42707.27
S.E. of regression	24961.76	Akaike info criterion	23.20455
Sum squared resid	8.72E+09	Schwarz criterion	23.30112
Log likelihood	-183.6364	HannanQuinn criter.	23.20949
F-statistic	29.90808	Durbin-Watson stat	0.634661
Prob(F-statistic)	0.000083		

Source: authors' own computation based on data published by Eurostat (NAMA_10_GDP, RAIL_IF_TRACKS)

6. Conclusions

Increase in mobility is the result of debatable investments since the decision of infrastructure development usually falls under the public administration responsibility and hence the allocation of public funds is always subject to argument. Therefore, there will always be a debate on expenditure of public funds and how they favour an economic or a social purpose (Fedderke et al., 2006).

Regarding the Romanian railway network, we already know that it had a large social impact, since it probably used to be Romania's largest employer during communism. This might be the reason behind its very large size. Also, an impressive volume of labour force was needed for its construction as it was needed for its maintenance in the years to come. Even so, the world changes, democracy has prevailed in Romania as in other developed regions across the world and the economic efficiency of such a large segment of the transport infrastructure is imperative.

Transport infrastructure can also stimulate economic development and implicitly the general wellbeing of the population. By opening to international trade and the international market, the local economy can benefit in ways such as stimulus for development in the local businesses, since in some industries transportation represents a large percentage of costs, the opportunity of benefiting from foreign direct investments and collaborations with neighbouring countries, thus not only stimulating economic relations but also people to people bonding (Wang, 2020).

The decreasing length of the railway infrastructure is not of primal concern since we understand its previous role, what concerns us is the small percentage of electrified tracks, the very short distances monitored by transport management systems, the high figures in terms of victims in accidents and the 31% fall in goods transported. The slower movement of goods can hinder the trade pattern between Romania and other countries and directly affect productivity which in turn reduces the various spill-over effects to other industries. The imports and exports growth rates are directly affected by the transport infrastructure performance thus a reduction in goods transported should not be accepted and suitable strategies must be put in place by those in charge to stop this trend as soon as possible (Yang et al., 2020). While most regional administrations are focused on reducing trade costs, the high numbers in victims of railway related accidents in Romania can suggest higher risk, thus higher costs and this directly affects international trade by forcing transporters into searching for other transport corridors.

The need for investments in the railway infrastructure is for reasons of safety and economic efficiency. Due to the lack of electrified lines, diesel locomotives still pollute some of the last virgin forests of Europe, but if this is not enough then the fact that diesel locomotives are very expensive for operators should convince the authorities to invest in this sector. Private development in terms of railway operators has been seen in the past years and this private involvement in the railway industry should be stimulated by facilitating an environment for it to flourish. As per data provided by the EUROSTAT platform, only 944 thousand tons of transit goods are transported yearly in Romania, Bulgaria just south of Romania with a railway network that is 27% of the length of the Romanian network transports 1451 thousand tons, 53.7% more than Romania.

A good management with a clear investment strategy and well-established development targets should generate an impressive return on investment for the Romanian Railways. Considering the optimal geographical positioning, the already extensive railway network, and the economic know-how as well as the financial support of the European Union, Romania should have its path paved with efficient and effective governmental initiatives.

Romania should act within the framework of the European transport policy and design its national policies in accordance with the European targets regarding the railway transport infrastructure. For example, Romania should implement safety standards that could mandate the infrastructure operator to invest in traffic management systems, in higher redundancy safety systems and technology that collects data to investigate the various causes of accidents. Train operators should go through a certification process in which they would have to adapt their systems to the one implemented by the infrastructure operator and mandate employees that are directly involved in the operation of vehicles to undergo safety training programs.

Regarding the environmental protection issue, an infrastructure master plan should be put in force for the electrification of railway tracks, with focus on main goods-transport routes and on those routes passing through areas in close vicinity to national parks or protected areas. Train operators should provide certification showing efforts made towards a more nature-friendly operation in accordance with the National Policies. European Cohesion Funds for large infrastructure should be a primal focus for the infrastructure operator, to invest in modernisation of lines and digitalisation to reduce the delay times as much as possible, hence encourage and facilitate optimal conditions for transport of goods.

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