

Article

Research on the Relationship between Transport Infrastructure and Performance in Rail and Road Freight Transport—A Case Study of Japan and Selected European Countries

Jozef Gnap ^{1,*}, Šimon Senko ¹, Mariusz Kostrzewski ², Mária Brídziková ¹, Renáta Czódorová ¹
and Zdeněk Říha ³

¹ Department of Road and Urban Transport, Faculty of Operation and Economics of Transport and Communications, University of Zilina, 01026 Zilina, Slovakia; simon.senko@fpedas.uniza.sk (Š.S.); maria.bridzikova@fpedas.uniza.sk (M.B.); renata.czodorova@stud.uniza.sk (R.C.)

² Department of Fundamentals in Means of Transport, Faculty of Transport, Warsaw University of Technology, 00662 Warsaw, Poland; mariusz.kostrzewski@pw.edu.pl

³ Department of Logistics and Transport Management, College of Logistics, 750 02 Přerov, Czech Republic; zdenek.riha@vslg.cz

* Correspondence: jozef.gnap@fpedas.uniza.sk; Tel.: +421-41-513-3500



Citation: Gnap, J.; Senko, Š.; Kostrzewski, M.; Brídziková, M.; Czódorová, R.; Říha, Z. Research on the Relationship between Transport Infrastructure and Performance in Rail and Road Freight Transport—A Case Study of Japan and Selected European Countries. *Sustainability* **2021**, *13*, 6654. <https://doi.org/10.3390/su13126654>

Academic Editors: Ján Ližbetin and Ondrej Stopka

Received: 9 May 2021

Accepted: 8 June 2021

Published: 11 June 2021

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



Copyright: © 2021 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

Abstract: Transport is key for our economy and society, as good transport infrastructure helps to improve the mobility of citizens and the flow of goods. The European Union intends to maintain support for the development of transport infrastructure in the individual Member States. The aim of this study was to use correlation analysis to compare selected parameters of the road and railway infrastructure of Japan and selected EU countries. The significance of the correlations between various parameters characterizing the transport infrastructure of Japan and selected EU countries was tested. Correlation analysis is not typical in transport-oriented research. Several studies have employed such analysis; however, the majority of them have focused on passenger transport and correlations concerning the behavior of the customers of this mode of transport. The aim of this study was to answer the following research question: is there any correlation between transport performance and infrastructure or investment in infrastructure in relation to the mentioned countries, and, if so, is there a connection between the selected countries where this correlation occurs? Greater investment can also be expected in the construction of high-speed railways, given the decisions of some EU Member States not to resume national air transport where there is good railway infrastructure, even after the end of the COVID-19 pandemic.

Keywords: freight transport; infrastructure; investment; correlation analysis; transport performance

1. Introduction

It is generally assumed that industry, logistics, and labor mobility do not function well without quality transport infrastructure and its maintenance. Moreover, a lack of investment in transport development deters international investors, affecting gross domestic product (GDP). The demand for freight transport is driven by economic growth [1–3].

Most of the past research focused on the impact of building transport infrastructure on GDP in specific regions through which the new transport infrastructure leads.

The issue of the dependence of the length of transport infrastructure on transport performance in rail and road freight transport was addressed by Gnap et al. [4], but only selected European countries were examined using correlation analysis, which may distort the overall view of the importance of transport infrastructure, especially if its new construction in the EU Member States of Central and Eastern Europe is largely funded by EU structural funds.

The aim of the research was to consider the original study of the investments in transport infrastructure, not only the length of transport infrastructure. A new research

question was also considered: on what do investments in transport infrastructure and the performance of road and rail freight transport depend? Moreover, the authors decided to compare the EU countries' circumstances with the adequate ones in Japan, as the latter is a country where the use of rail passenger transport is highly developed and recognized. However, the development of rail freight transport is less commonly researched. It should be underlined that passenger transport is of greater interest to rail companies than freight in Japan, for several reasons, e.g., the country's population, geographical distribution (an island country, stretching mainly in the northeast–southwest direction, characterized by long distances between localities), and both foreign and domestic tourism, shifting the burden of cargo delivery to maritime transport. The authors focus on these aspects and freight transport in Japan, in general, in the future; therefore, they are only briefly highlighted in this introduction. The data necessary for the research were obtained during a research visit by one of the coauthors of the paper in 2019 in Japan.

The main research question is whether there is any correlation between transport performance and infrastructure or transport performance and investment in infrastructure in relation to the mentioned countries and, if so, whether there is a connection between the selected countries where this correlation occurs.

The results of the research can in part help to decide on the priorities and benefits of investing in road and rail transport infrastructure. The transport infrastructure does not only need to be built, but it is necessary to ensure its continuous maintenance and repairs in order for its safe operation to be sustainable in the long run. This aspect is forgotten, especially in short-term planning, which is often linked to the election terms. The new or significantly reconstructed transport infrastructure also impacts transport performance in freight transport. Is it approximately the same in all countries surveyed? This question was also examined in this study.

2. Literature Review

The importance of transport infrastructure in terms of the transnational logistics chain is described in detail by Grakh et al. [5], who address the redistribution of power to high-speed infrastructure in road, but mainly rail, transport. The need for quality infrastructure is further described by Aswal [6], who highlights the need for, inter alia, industrial development, international trade, sustainable energy sources, and foreign investment. Rokick et al. examined the impact of the significant completion of motorways between 2005 (500 km) and 2015 (3000 km) on GDP growth and employment in the regions connected by the new transport infrastructures [7]. The relationship between transport infrastructure and urban economic growth was examined based on a sample of 216 cities in China [8]. The impact of the construction of high-speed railways in Italy on the economic growth and accessibility of the regions over a 10 year period is addressed by Cascetta et al. [9]. The Granger causality between wealth and transport was examined based on a data sample involving 18 countries between 1970 and 2017 [10]. Another contribution quantified the direct and indirect effects of part of the completed TEN-T corridors in the eastern part of the EU on regional GDP growth. Data and developed spatial analyses showed that regional GDP growth at the third level of the Nomenclature of Territorial Units for Statistics NUTS3 is 0.5–2% higher if the region has direct access to the newly built road [11].

Skorobogatova and Kuzmina-Merlino outlined the issue of creating a methodology for the correct calculation of transport performance [12]. The authors also describe how appropriate transport infrastructure has a positive effect on the economic and social development of the areas in which it is built.

Torrise (2009) [13] compared different methodologies for examining the impact of infrastructure on the economy, comparing four basic approaches to this analysis. The author shows that, even with the use of different methodologies, it is demonstrable that infrastructure development has a positive impact on domestic economies.

Financing infrastructure can be challenging, especially in developing countries. Correlation analysis was used to examine the impact of development aid investment in road transport infrastructure in Vietnam on GDP growth [14].

The developed infrastructure should be treated with special care regarding aspects of sustainability. The issue of financing low-emission infrastructures, specifically in Japan, was addressed by Schumacher et al. [15]. Research on investment in political-economic infrastructure has also been conducted by Lorz [16] and Baum-Snow et al. [17]. Their research, in turn, showed that countries that are more export oriented than import oriented more strongly emphasize building ground infrastructure. Bond [18] further examined the impact of investment in transport infrastructure and how cooperation in building international infrastructure connections may ultimately lead to lower transport costs. In their contribution [19], the Polish researchers Kowalski and Wiśniewski pointed out that investments affect changes in transport accessibility and mobility, as well as resulting in changes in traffic flows. Further research has been carried out in China to determine the impact of motorway construction and regional interconnections on GDP, the environment, and CO₂ emissions [20,21].

The need to build TEN-T corridors to connect Western and Eastern Europe and the availability of this infrastructure was investigated using regression analysis [11]. The results of the study of improving accessibility by building new road transport infrastructure using an econometric model can be found in [22]. Research in China has also been carried out using correlation analysis to increase the impact of new transport corridors and hubs on GDP and the number of residents [23]. Another study, using correlation analysis, was conducted on how the intensity of traffic on motorways correlates with an indicator of regional economic development [24]. A similar output was realized in Mongolia for the period of 2000–2016, where the relationship between economic growth and traffic intensity according to transport infrastructure was examined [25]. Correlation analysis was also applied to examine the impact of development aid investment in road transport infrastructure in Vietnam on GDP growth [14].

The need to build transport infrastructure, especially with the aim of connecting regions, and to build integrated transport systems competitive with individual transport also requires the application of methods for setting construction priorities, as pointed out by Gasparik et al. [26]. Both road and rail transport infrastructures are necessary to connect intermodal terminals to support the increased use of sustainable transport sectors [27]. It is also important to increase the capacity of railway lines, where they are at the limit of permeability for rail freight [28]. It is also necessary to revitalize regional railway lines if they are important for freight transport and integrated public passenger transport systems, as suggested by the authors in [29,30] for the example of Slovakia and Serbia.

The built transport infrastructure requires regular maintenance and, due to climate change, the additional construction of flood protection systems. Koks et al. point out that the annual cost of direct damage to road and rail infrastructure ranges from 3.1–22 billion dollars globally, 73% of which is caused by floods [31]. The study did not take into account the additional damage associated with the malfunction of the transport infrastructure during repair. Dynamic weighing is important for the protection of new or reconstructed railway transport infrastructure as well as the correct collection of charges for their use [32].

In order to increase rail freight performance, it is also important to address tariffs in order to be competitive, particularly against road freight [33]. The prices in international road freight transport can be significantly affected by the harmonization of social regulations, especially in the area of minimum wages for drivers [34].

As can be concluded based on the conducted literature review, investments in transport infrastructure are little researched, and most of the research concerns only one mode of transport. Therefore, it is worth analyzing investments in transport infrastructure from a broader perspective, not only the straightforward length of transport infrastructure. Consequently, the authors decided to consider a new research question that was noted in the introduction: on what do investments in transport infrastructure and the performance

of road and rail freight transport depend, from the perspective of the selected countries? To answer this question, the appropriate methodology was applied, and an appropriate set of materials and data was collected and analyzed.

3. Materials and Methods

As already mentioned, previous research has focused mainly on the impact of building transport infrastructure on the change in GDP in the specific regions through which the new transport infrastructure leads.

Our proposed methodology examines the dependence of the length of transport infrastructure and also the investment in transport infrastructure on transport performance in road and rail freight transport. Transport performance of road and rail freight transport is related to economic activity in the given state's respective region, especially with industrial production. A number of politicians are calling for the construction of new transport infrastructure in their regions in order to attract investment in industry in particular.

Japan was selected on the basis of well-known high-quality rail passenger transport, but knowledge about rail freight is not widely published. The data needed for carrying out the research were obtained during a study visit to Japan by one of the coauthors.

We examined possible data sources in the first step of our research. In order to correctly calculate the correlation coefficients, it was necessary to appropriately analyze data obtained from reliable sources. Therefore, the data were drawn from the Eurostat and Organisation for Economic Cooperation and Development (OECD) databases. However, not all data were available for all countries under the period studied. Therefore, the missing data were computed using trend curves based on moving averages.

The coefficients of the correlation between transport performance (X , further noted as X^{road} and X^{rail} in relation to certain modes of transport) and the length of the infrastructures (Y , further noted as Y^{road} and Y^{rail} in relation to certain modes of transport) were calculated, and it was verified whether the calculated correlation dependences between X and Y (X and Y —each separately is a data sample, a set of individuals or objects collected or selected from a statistical population) were statistically significant or random. To verify statistical significance, we used a 0.05 p -value for the α test. The null hypothesis (H_0) was that there is no statistically significant linear dependence ($Y = X$) between Y and X (outputs and network length); the alternative hypothesis (H_1) was that there is a statistically significant linear dependence between Y and X (outputs and network length) ($r_{xy} \neq 0$). The same procedure was followed when calculating the coefficients of the correlation between transport performance (X , further noted as X^{road} and X^{rail} in relation to certain modes of transport) and infrastructure investment (YI , further noted as YI^{road} and YI^{rail} in relation to certain modes of transport).

After calculating the correlation coefficients and verifying the statistical significance, other relative indicators were developed: the length of the infrastructure to the area of the territory and the length of the infrastructure to 1 million inhabitants. These values are shown in graphs further down in the paper for better visualization.

3.1. Correlation Analysis

The dependence of two random variables is evaluated with a simple correlation analysis, which places more emphasis on the intensity of the relationship than on investigating the variables in the cause–effect direction (regression). The dependences it examines are mainly linear, where the correlation, from the Latin *correlatio* [cor-together + relation-relationship], is a measure of the linear relationship. It is important to note that correlation is not causality. Quantities that correlate with each other are probably interdependent, but it cannot be concluded that they are conditional. The aim of correlation analysis is to identify, quantify, and statistically test correlation. A necessary part is a logical analysis of the problem, in terms of the significance of the correlation itself, which may be distorted or not exist at all. When using two-dimensional methods, a false correlation often occurs, which is an apparent but nonexistent correlation between the variables X

and Y (any; not related to the notations assigned in the currently developed research—this generalization only concerns the data in Section 3.1) that appears to be strong due to other (disregarded) variables. The value of correlation is also affected by a lack of homogeneity in a sample and the formal relationship between the quantities (e.g., in the correlation of percentage characteristics, which are supplemented to 100%). The tool of correlation analysis is the so-called correlation coefficient (denoted by r_{xy}). This tool determines the degree of tightness (degree) of dependence. The correlation coefficient is a measure of the linear dependence of two variables and can be expressed by the following relation (1):

$$r_{xy} = \frac{\sum_{i=1}^n (x_i - \bar{x}) \cdot (y_i - \bar{y})}{\sqrt{\sum_{i=1}^n (x_i - \bar{x})^2 \cdot (y_i - \bar{y})^2}} \quad (1)$$

A common task in mathematical statistics is to determine whether random variables X and Y are correlated or not. The value of the correlation coefficient depends on the elements that were randomly selected. If the value of the correlation coefficient is close to zero, it shows that the value is only random (caused by random selection) or really represents a linear independence. The linear independence test is used for verification. To determine whether the random variables X and Y are correlated or not, the null hypothesis (H_0) $\rho = 0$ is evaluated against the alternative hypothesis (H_1) $\rho \neq 0$.

The correlation coefficient takes values in the interval $\langle -1, +1 \rangle$. If $r_{xy} = 1$, then a positive linear relationship between X and Y can be considered: i.e., larger values of X correspond to larger values of Y and vice versa. If $r_{xy} = -1$, then a negative correlation between the X and Y can be regarded (a markedly opposite relationship): larger values of X correspond to smaller values of Y and vice versa. In the case of independence between the values of X and Y , the correlation coefficient is close to 0. In this case, the values of X and Y are scattered independently of each other. The correlation coefficient can be 0 even if there is a statistical relationship, other than linear, between X and Y . A positive correlation coefficient shows direct dependence, and negative values, indirect dependence. Other values of the correlation coefficient can be interpreted as follows: (it is worth remembering that the following thresholds are guidelines, and a dependence also relies on what sort of data are compared—the presented thresholds are based on the authors' experience):

- If $0 \leq |r_{xy}| < 0.4$, there is a weak dependence between X and Y ;
- If $0.4 \leq |r_{xy}| < 0.8$, there is a moderate dependence between X and Y ;
- If $|r_{xy}| \geq 0.8$, there is a strong dependence between X and Y .

3.2. Data in the Analysis

Data were drawn from the Eurostat and OECD databases. The absolute values of the examined parameters of infrastructure, performance, and investment are given in the Supplementary Material. Table S1 consists of the length of the railway network and its development for the period 2004–2018. In addition to Japan, 27 selected European countries were assessed, three of which were non-EU countries (Norway, Ukraine, and Switzerland). In the Supplementary Material Table S2, the length of the road network and its development for the period 2004–2018 are given. Supplementary Material Table S3 shows the transport performance in rail freight transport in millions of tonne-kilometers, which were realized in the assessed countries for the period 2004–2018, and in Supplementary Material Table S4, the performance of road freight transport is presented.

In its transport and cohesion policy strategy, the EU promotes the interconnection of Member States, particularly through the superior TEN-T transport infrastructure. In some Central and Eastern European countries, the EU Structural Funds are the most important source of investment in transport infrastructure. Therefore, we also examined the development of investments in road transport infrastructure for the individual countries studied and the period 2004–2018, as described in the Supplementary Material Table S5. In the Supplementary Material Table S6, investments into railway transport infrastructure, in millions of euros, are described.

4. Results

The first results were obtained by calculating the length of the road infrastructure in km per area in km^2 for the studied countries (Figure 1). According to this indicator, Japan is the best; of the European countries, Hungary is in first place and Slovenia in third. Portugal is last with 0.12 km of road infrastructure per 1 km^2 of area. This is partly understandable because it is not an EU transit state. In second place, with the lowest length in km per 1 km^2 of area, is Bulgaria, which is a member of the EU and is a transit country from Turkey and, partly, Greece.

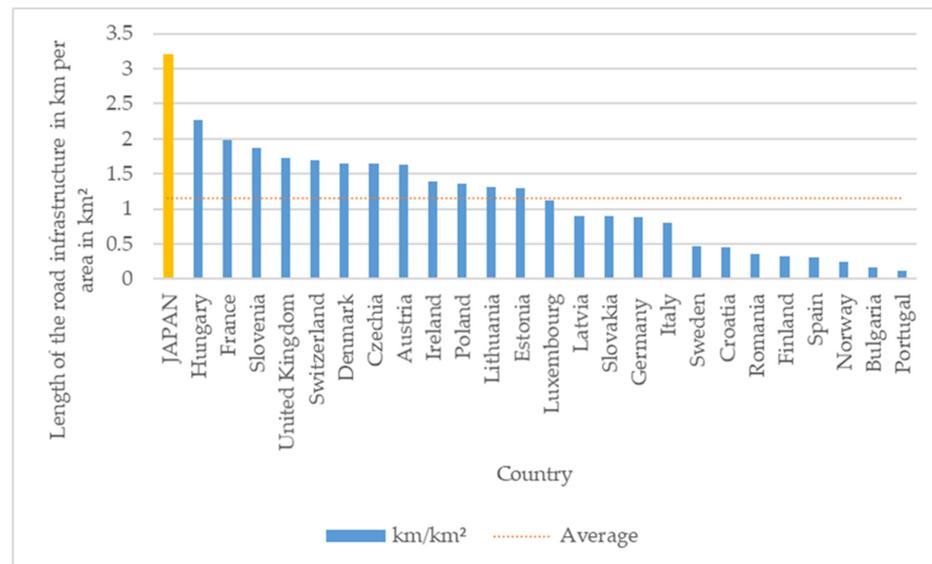


Figure 1. Road infrastructure in km/km^2 area of selected countries.

According to the length of road infrastructure in km per 1 million inhabitants (Figure 2), Japan is in 15th place. Of the European countries, Estonia is interestingly in first place, followed by the other Baltic states of Latvia and Lithuania. Portugal and Bulgaria have the least length of road infrastructure per 1 million inhabitants. Interestingly, Norway ranks third from last according to the first indicator, length per area (Figure 1), but it is significantly better in terms of length per population.

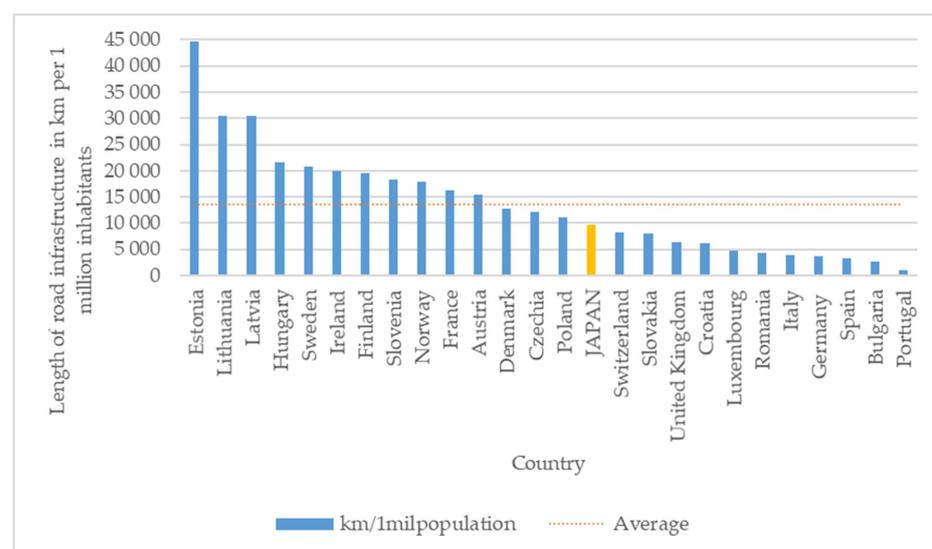


Figure 2. Road infrastructure in $\text{km}/1 \text{ mil. inhabitants}$ of selected countries.

The length of the railway infrastructure in km per km² of area of the studied countries was calculated (Figure 3). According to this indicator, the three EU countries are the best—the Czech Republic, Luxembourg, and Germany—followed by a non-EU country, Switzerland, which has built transport infrastructure from its own resources. Japan is in 13th place according to this indicator. The Nordic states of Norway, Finland, and Sweden, as well as Greece, have the least km of railway infrastructure per km². This is partly understandable because they are not transit states, and in the case of Greece, the islands, of which there are over 2000, are also included in the area.

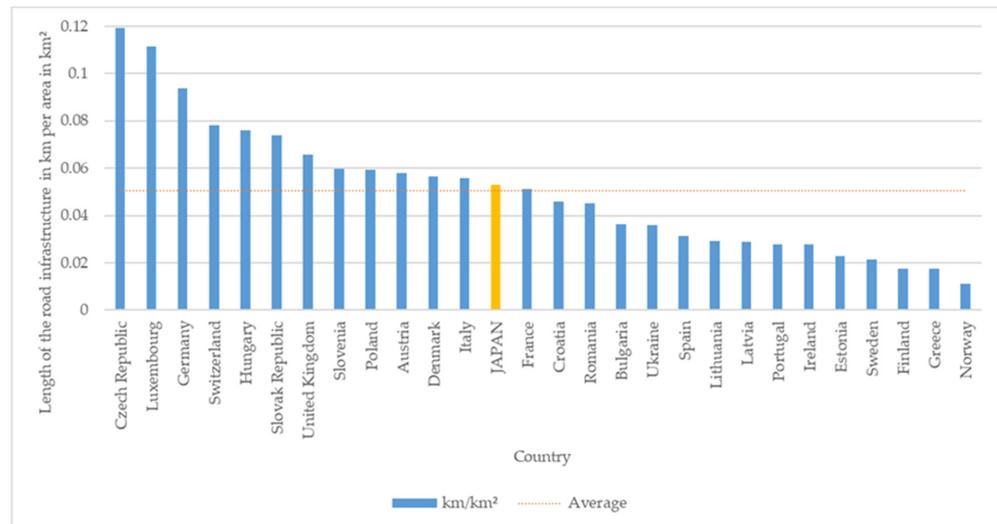


Figure 3. Rail infrastructure in km/area in km² of selected countries.

The low position of Japan according to the length of the railway infrastructure per 1 million inhabitants (Figure 4) is interesting; Japan is at the bottom, with the lowest value of 159.92 km of network per 1 million inhabitants. Finland, Lithuania, and Sweden rank the highest.

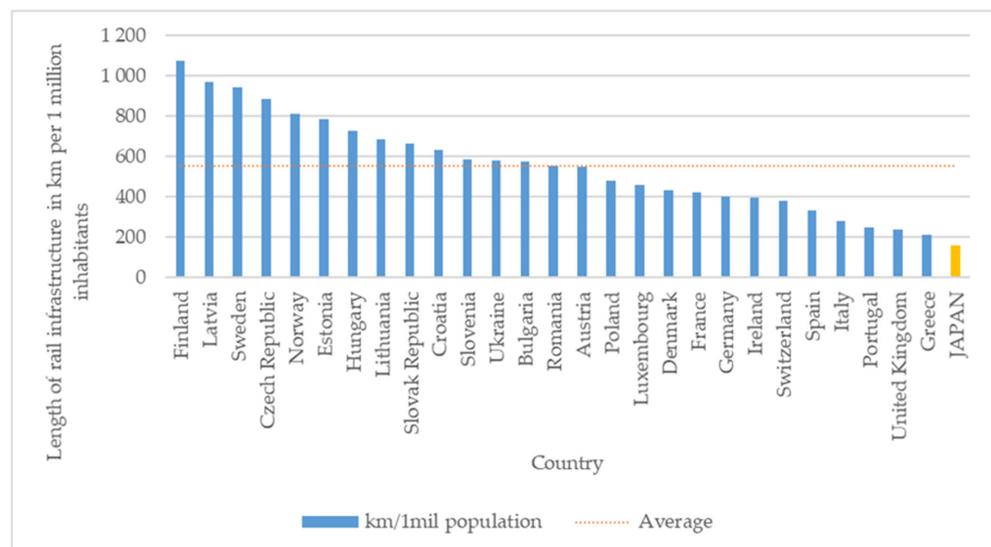


Figure 4. Rail infrastructure in km/1 mil. inhabitants of the selected countries.

The above comparison shows that it is not only the length of the transport infrastructure that matters; quality and performance are also important. Additionally, some countries that are not in transit have built infrastructure mainly for their own needs.

Therefore, the main research was focused on examining the correlation between the length of railway infrastructure and the performance of rail freight transport (Table 1 and Figure 5). Various statistical programs are currently used to process statistical files, which can process large data files relatively quickly. In the research, we focused not only on the calculation of the correlation coefficient but also on whether there was a statistically significant linear relationship between the variables. The decision (whether there is a statistically significant linear relationship between the variables) is made according to the p -value of the test. An important step is to define the null hypothesis (H0) and the alternative hypothesis (H1); we choose the significance level $\alpha = 0.05$. In the last step, we define a p -value: if the p -value $> \alpha$, then we do not reject H0; if the p -value $< \alpha$, we reject H0 and accept H1.

Table 1. Correlation between infrastructure length and performance (rail transport).

	Country	Correlation Coefficient	Statistical Significance
Strong direct dependence	Greece	0.810285	0.000249
	Romania	0.701117	0.004
Moderate direct dependence	Bulgaria	0.667511	0.007
	Norway	0.642702	0.010
	Denmark	0.639023	0.010
	Lithuania	0.504717	0.055
	Ukraine	0.479291	0.071
	Croatia	0.426861	0.113
	Switzerland	0.365045	0.181
	Slovak Republic	0.335579	0.221
Weak direct dependence	Japan	0.298992	0.279
	Sweden	0.172610	0.538
	France	0.154003	0.584
	Ireland	0.117675	0.676
	Latvia	0.006803	0.981
Weak indirect dependence	Finland	−0.108000	0.702
	Luxembourg	−0.157040	0.576
	Czech Republic	−0.275710	0.32
Moderate indirect dependence	Estonia	−0.302170	0.274
	Austria	−0.315690	0.252
	United Kingdom	−0.339980	0.215
	Poland	−0.416140	0.123
	Portugal	−0.474150	0.074
	Italy	−0.477770	0.072
	Spain	−0.511430	0.051
	Hungary	−0.573770	0.025
	Slovenia	−0.737130	0.002
	Germany	−0.755870	0.001

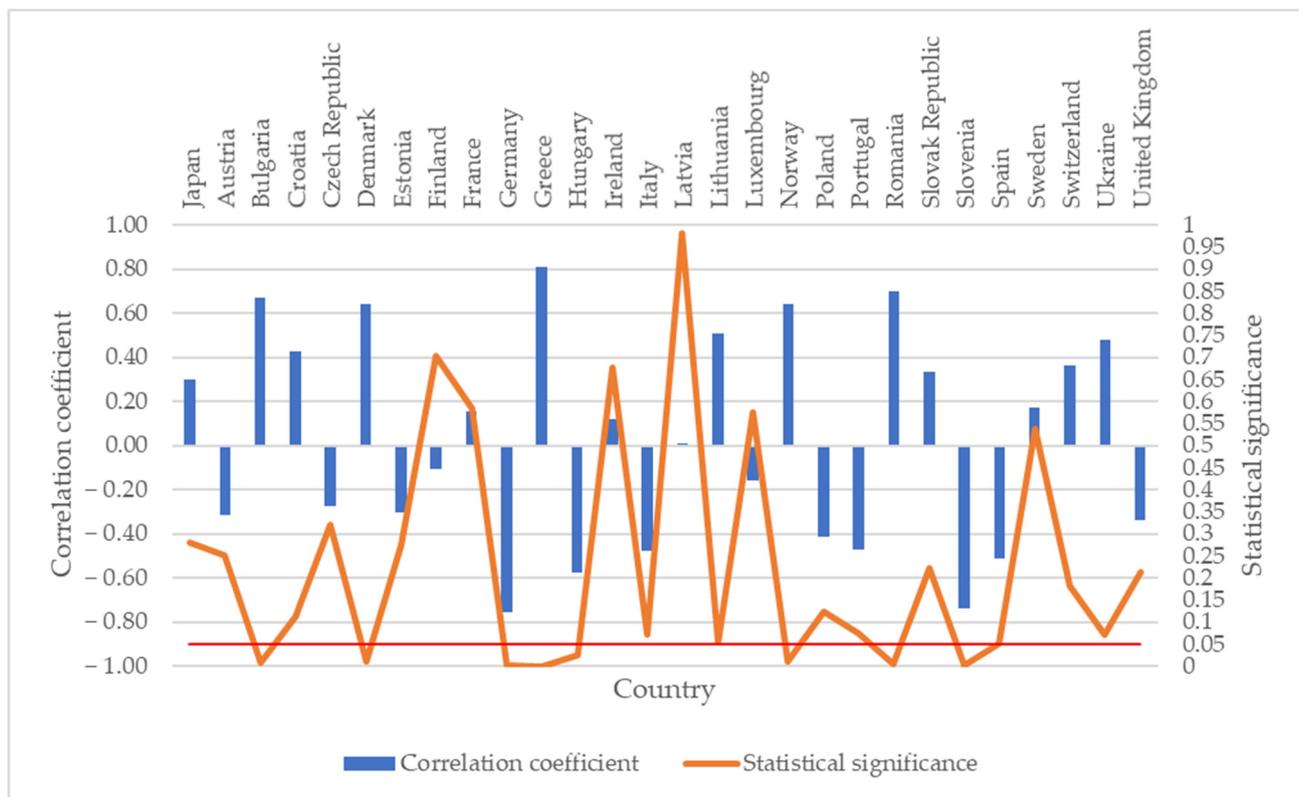


Figure 5. Graph showing the correlation between infrastructure length and performance (rail transport).

The calculated correlation coefficients and the values of statistical significance are given in Table 1. In the case of Greece, Romania, Bulgaria, Norway, and Denmark, the p -values $< \alpha$ refute H_0 , and we accept H_1 . Thus, there is a statistically significant linear relationship between Y^{rail} and X^{rail} (the length of infrastructure and transport performance realized by rail transport). In the case of the abovementioned countries, the correlation coefficients range from 0.810285 to 0.639023, i.e., from a strong direct dependence to a medium direct dependence. These values can be interpreted as meaning that the length of the infrastructure significantly influences the performance realized by rail freight transport.

In the case of Hungary, Slovenia, and Germany, the p -values $< \alpha$ refute H_0 and support H_1 . Thus, there is a statistically significant linear relationship between Y^{rail} and X^{rail} (the length of infrastructure and the performance realized by rail transport). In the case of the abovementioned countries, the correlation coefficients range from -0.57377 to -0.75587 , i.e., they show a medium indirect dependence. For the countries concerned, the coefficient shows that the length of the infrastructure does not affect the services that are provided by rail freight transport.

In the case of other states, the p -values $> \alpha$ do not refute H_0 , i.e., there is no statistically significant linear relationship between Y^{rail} and X^{rail} (the length of infrastructure and the transport performance realized by rail freight transport).

Further results regarding the correlation between the length of road infrastructure and transport performance in road freight transport are shown in Table 2 and Figure 6.

We carried out a similar study in the case of road freight transport. In addition to calculating the correlation coefficient, we also examined whether there was a statistical dependence between the variables. All the conditions remained the same as when we examined whether a statistical dependence occurred between the length of the infrastructure and the performance in rail freight transport.

Table 2. Correlation between infrastructure length and performance (road transport).

	Country	Correlation Coefficient	Statistical Significance
Strong direct dependence	Germany	0.996940	8.85×10^{-16}
	Bulgaria	0.958141	1.96×10^{-8}
	Poland	0.919980	0.000001
	Norway	0.912409	0.000002
	Hungary	0.861482	0.000037
	Lithuania	0.819703	0.000184
Moderate direct dependence	Denmark	0.643264	0.010000
	Slovak Republic	0.589622	0.021000
	Czech Republic	0.544200	0.036000
	Spain	0.459057	0.085000
Weak direct dependence	Sweden	0.419061	0.120000
	Austria	0.053067	0.851000
Weak indirect dependence	Ireland	0.004843	0.986000
	Romania	−0.098220	0.728000
	Switzerland	−0.137490	0.625000
	Croatia	−0.208180	0.457000
	Slovenia	−0.209400	0.454000
Moderate indirect dependence	Estonia	−0.261150	0.347000
	United Kingdom	−0.346920	0.205000
	Italy	−0.432860	0.107000
	Finland	−0.651060	0.009000
	Portugal	−0.651800	0.008000
Strong indirect dependence	Latvia	−0.740490	0.002000
	France	−0.861560	0.000037
	Japan	−0.878020	0.000017
	Luxembourg	−0.891140	0.000008

In the case of Germany, Bulgaria, Poland, Norway, Hungary, Lithuania, Denmark, Slovakia, and the Czech Republic, the p -values $< \alpha$; therefore, we reject H_0 and accept H_1 . There is a statistically significant linear relationship between Y^{road} and X^{road} (between the length of infrastructure and the performance of road transport). The strength of the relationship ranges from strong to moderately direct dependence (Table 2). It follows that the length of the infrastructure in the concerned countries affects the performance of road transport. A strong-to-medium indirect relationship in Finland, Portugal, Latvia, France, Japan, and Luxembourg was observed. The indirect relationship determines that the length of the infrastructure does not affect the road transport performance. In the case of the other states listed in Table 2, the p -values $> \alpha$; thus, H_0 is not rejected. No statistically significant linear relationship between Y^{road} and X^{road} can be stated (between the length of the infrastructure and the services provided by road transport).

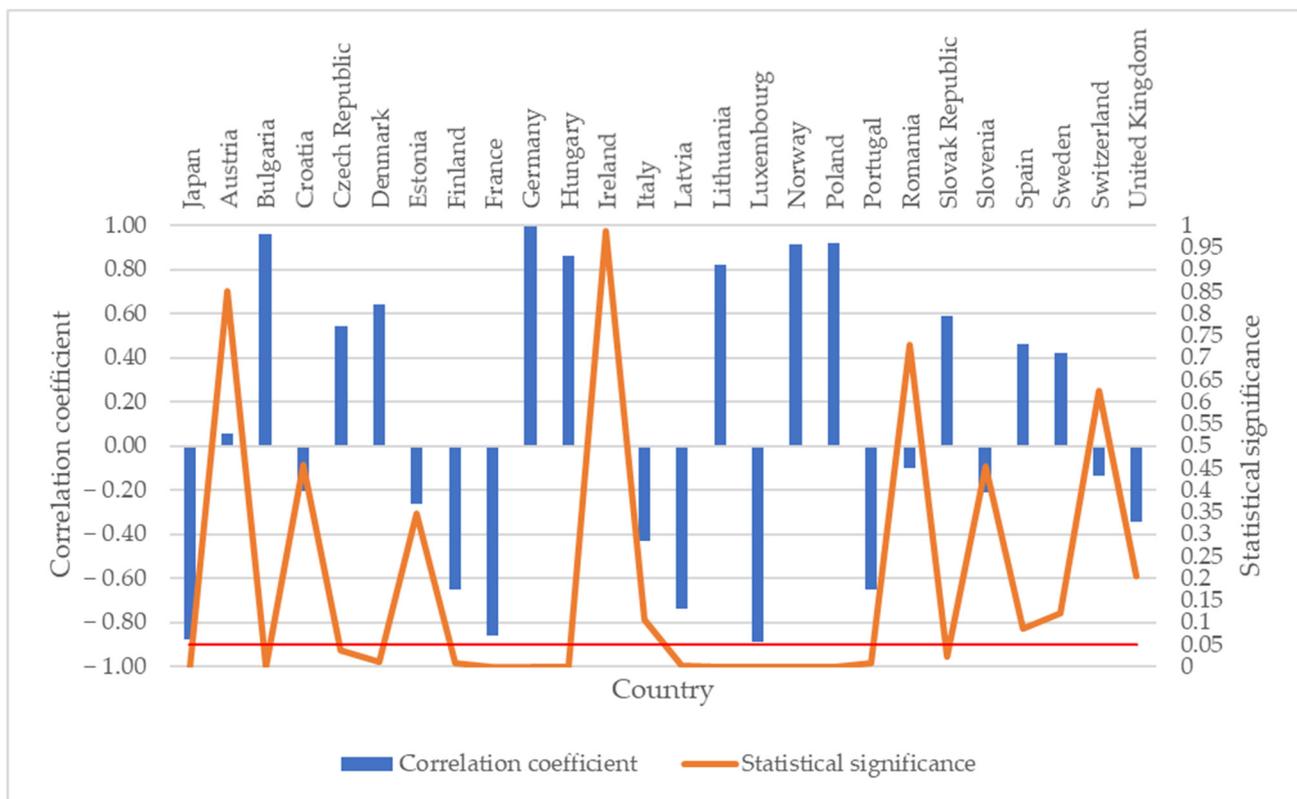


Figure 6. Graph showing correlation between infrastructure length and performance (road transport).

Transport infrastructure needs to be built or continuously repaired, and therefore, further research focused on examining the correlation between investments in road infrastructure and the performance of road freight transport (Table 3 and Figure 7). In this case, in addition to the correlation coefficient, we also examined whether statistically significant linear relationships between particular variables occurred. The conditions for determining the p -value, as well as the expression of the null and alternative hypotheses and the determination of the α level of significance, remained the same throughout the research. In the case of road transport (Ireland, Latvia, Austria, Slovakia, Denmark, Sweden, Slovenia, Italy, and France), the p -values $< \alpha$, refuting H_0 and supporting H_1 ; there is a statistically significant linear relationship between $Y1^{road}$ and X^{road} (between infrastructure investment and the performance realized by road transport). The correlation coefficients showed strong-to-moderate direct dependence. This is connected to the fact that investments in infrastructure in the given states also directly affect the performance realized there by road transport. A statistically significant linear relationship was also confirmed in the case of Finland and Luxembourg; however, the correlation coefficients for these countries are negative (strong and moderate indirect dependences): i.e., infrastructure investment does not affect the performance of road freight transport. In the case of the other states, the p -values $> \alpha$; we do not reject H_0 , i.e., there is no statistically significant linear relationship between the variables $Y1^{road}$ and X^{road} (infrastructure investment and output).

Table 3. Correlation between infrastructure investment and performance (road transport).

	Country	Correlation Coefficient	Statistical Significance
Strong direct dependence	Norway	0.938216	2.43×10^{-7}
	Ireland	0.840858	0.000086
Moderate direct dependence	Latvia	0.796292	0.000382
	Austria	0.724232	0.002000
	Slovak Republic	0.708867	0.003000
	Denmark	0.706046	0.003000
	Sweden	0.668102	0.006000
	Slovenia	0.665292	0.007000
	Italy	0.661326	0.007000
	France	0.548503	0.034000
	Japan	0.408095	0.131000
	Spain	0.385272	0.156000
	Switzerland	0.380736	0.161000
	Bulgaria	0.329328	0.231000
	Weak direct dependence	Lithuania	0.232906
Poland		0.036007	0.899000
Weak indirect dependence	Croatia	−0.033790	0.905000
	Romania	−0.168820	0.548000
	United Kingdom	−0.174790	0.533000
	Estonia	−0.198750	0.478000
	Germany	−0.219330	0.432000
	Hungary	−0.222290	0.426000
	Czech Republic	−0.260590	0.348000
Moderate indirect dependence	Finland	−0.789820	0.000460
Strong indirect dependence	Luxembourg	−0.813090	0.000228

In particular, the European Union supports investment in rail transport infrastructure in order to change the modal split between road freight and rail freight. The results from examining the correlation between investments in railway infrastructure and the performance of rail freight transport are shown in Table 4 and Figure 8. Regarding rail transport, there is a statistically significant relationship between investments in infrastructure, and the services are realized within rail transport in the case of Denmark, Norway, United Kingdom, Luxembourg, France, and Japan. In the case of Denmark and Norway, a strong-to-medium direct dependence between the variables is observed, which means that investment in infrastructure affects the performance of rail transport in these countries. The opposite can be observed for United Kingdom, Luxembourg, France, and Japan, where we observe a medium indirect dependence: i.e., investments in infrastructure do not affect the performance realized by rail freight transport. In the case of other countries, no statistically significant linear relationship was noted between the variables $Y1^{rail}$ and X^{rail} (the investments in infrastructure and services provided by rail freight).

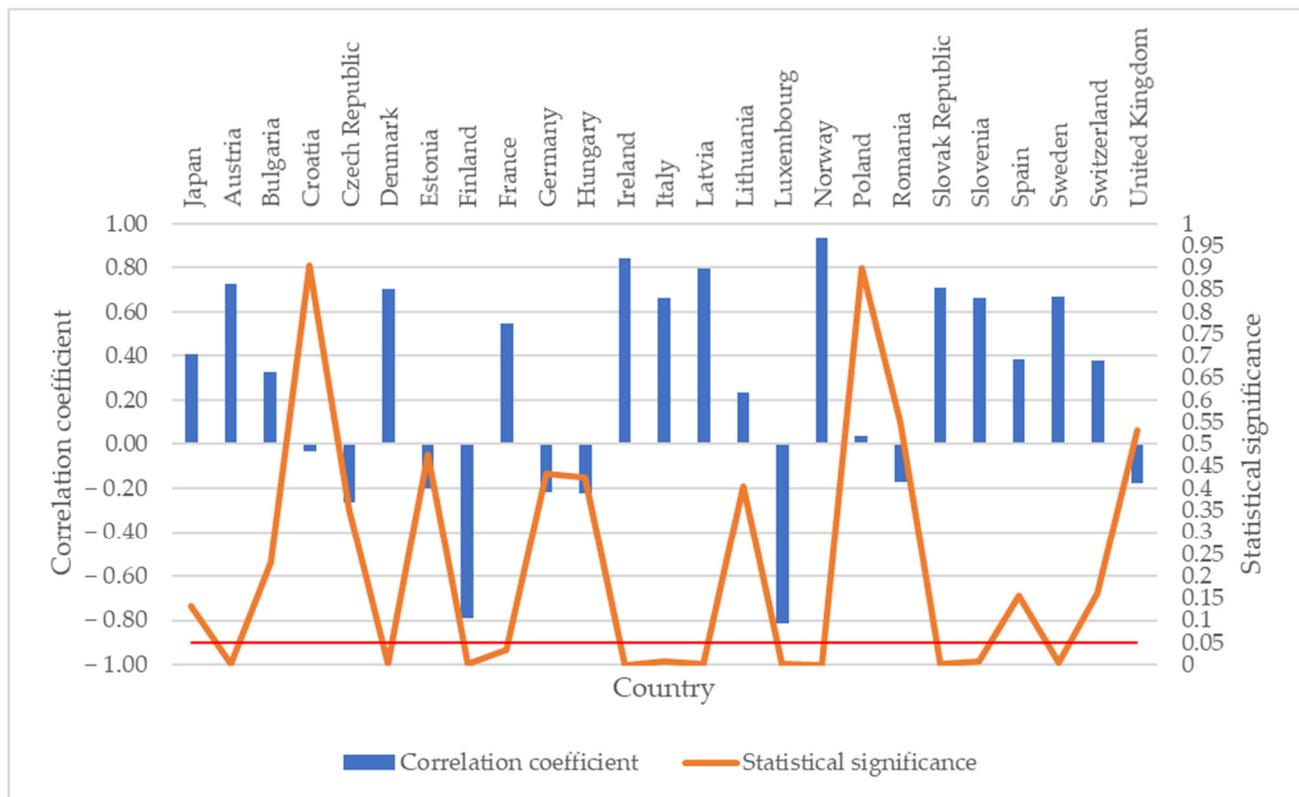


Figure 7. Graph showing correlation between infrastructure investment and performance (road transport).

Table 4. Correlation between investment in infrastructure and performance (rail transport).

	Country	Correlation Coefficient	Statistical Significance
Strong direct dependence	Denmark	0.903216	0.000004
	Norway	0.712603	0.003000
Moderate direct dependence	Hungary	0.444276	0.097000
	Italy	0.420524	0.119000
	Slovenia	0.413276	0.126000
	Latvia	0.388135	0.153000
	Sweden	0.310761	0.260000
	Greece	0.294341	0.287000
Weak direct dependence	Lithuania	0.262521	0.365000
	Germany	0.173627	0.536000
	Switzerland	0.163038	0.562000
	Czech Republic	0.161668	0.565000
	Estonia	0.149971	0.594000
Weak indirect dependence	Poland	0.112352	0.690000
	Croatia	0.083300	0.768000
	Austria	-0.043400	0.878000
	Slovak Republic	-0.234370	0.400000
	Spain	-0.283000	0.307000

Table 4. Cont.

	Country	Correlation Coefficient	Statistical Significance
Moderate indirect dependence	Finland	−0.367250	0.178000
	Romania	−0.378840	0.164000
	Bulgaria	−0.433190	0.107000
	Portugal	−0.465550	0.080000
	United Kingdom	−0.610100	0.016000
	Luxembourg	−0.628970	0.012000
	France	−0.68070	0.005000
Strong indirect dependence	Japan	−0.899640	0.000005

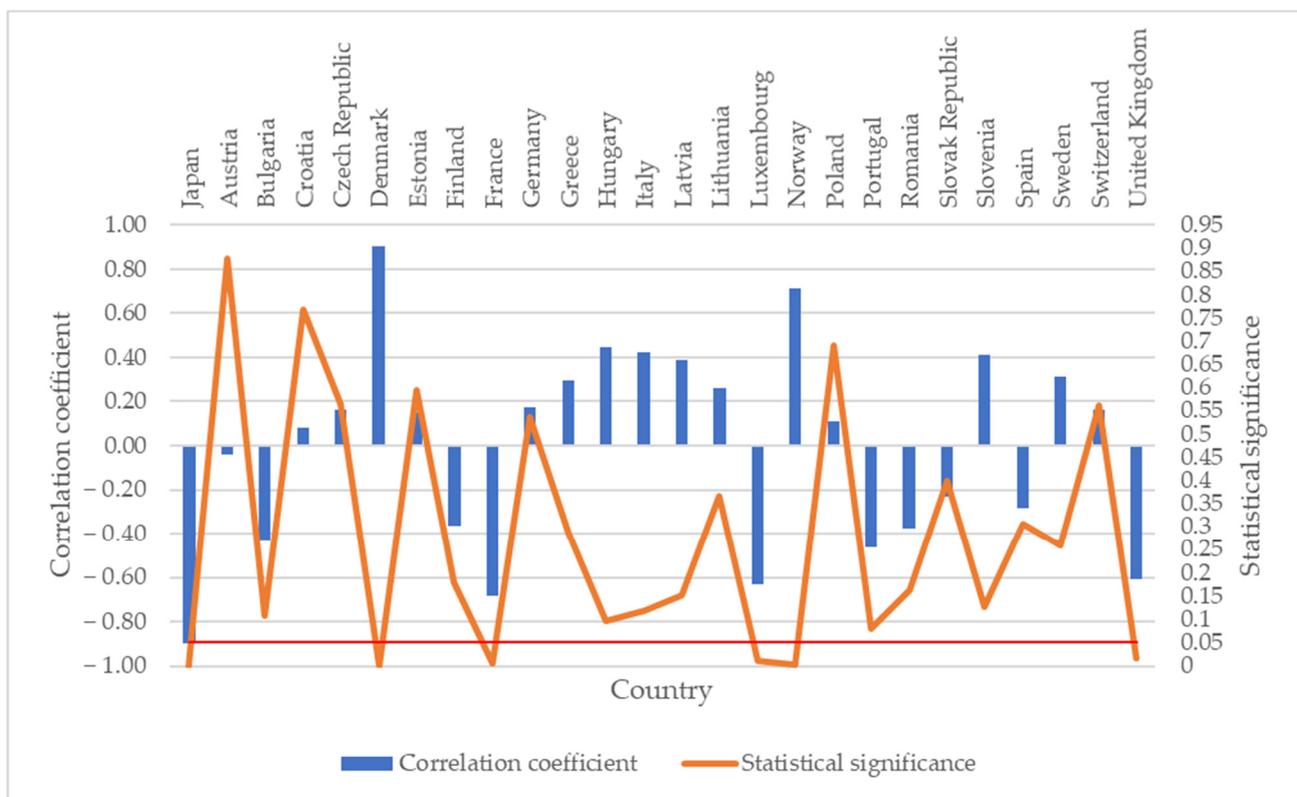


Figure 8. Graph showing correlation between infrastructure investment and performance (rail transport).

5. Discussion and Conclusions

In general, it can be concluded that the study of correlations in which performance is one of the dependent variables makes more sense in road transport than in rail transport, as the results show that greater statistical significance could be observed for road transport than at the railway. The topic of correlation in transport needs to be given more attention in further research.

The results of the correlation analysis show that, if we compare Japan with European countries, the country that behaves the most similarly according to the results of the correlation is France. Not only are France and Japan equal in the results, but their resulting values for the correlation coefficient are often very similar. There was a difference in the correlations between the investment in infrastructure and rail transport performance; however, France ranks second after Japan but shows a different value of the resulting correlation.

Countries considered to be more economically developed show stronger correlations between infrastructure performance and investment, regardless of direct or indirect dependence. This was not observed regarding the length of the infrastructure and its performance. When examining the relative indicators of infrastructure, it is possible to note from the results that, if we observe the parameters (values) for the length of infrastructure relative to the territory of the state (the area in km²), Japan and France show very similar values. In road infrastructure, Japan ranked first owing to a very developed road infrastructure network.

However, Japan performs much worse according to the road infrastructure per 1 million inhabitants, below average. Japan was even in last place in terms of the railway infrastructure per 1 million inhabitants, with 159.92 km of network per 1 million inhabitants. However, Japan has a very well-established network of high-speed trains (eight Shinkansen system main lines) for rail passenger transport with a large number of transported passengers, which compensates for the smaller extent of road infrastructure. It should be underlined that the Shinkansen bullet train system does not transport freight. One of the biggest rail freight companies in Japan is JR Freight. The company rents infrastructure from other companies (passenger ones) [35], which makes freight transport dependent on the time windows between passengers' transportation. Additionally, Japan, as an island country, does not have transit road freight transport like a number of European countries such as Germany, Austria, Slovakia, and the Czech Republic.

Another factor that can reduce transport performance in tonne-kilometers, especially in rail and also partly in road freight transport, is the use of coastal sea transport or river freight transport. Here, we see the possibility of refining the research of the relationship between the need for transport infrastructure for freight transport as an important factor for the economic development of regions based on industry and the extraction and processing of raw materials. In the selection of European countries for research, we also did not consider typical island states such as Cyprus and Malta, which no longer have a railway transport infrastructure in operation.

France and Japan are among the founding states of the so-called Group of Seven (G7) of the most developed countries in the world and also have access to the sea, and thus, part of the transport of goods can be realized by coastal maritime transport, which may be one of the reasons that they have similar results.

In terms of the correlation between the length of infrastructure and the performance in rail transport or road transport, we found a statistically significant linear relationship between the pairs of variables $Y^{rail} - X^{rail}$ and $Y^{road} - X^{road}$ in different countries. Therefore, it is necessary to focus further research on the correlations between those variables in countries where the core network is clearly defined, while at the same time analyzing in more depth the countries in which the correlations for road and rail transport have intersected.

The results of the correlation between the length of railway infrastructure and performance in rail freight transport show a statistically significant relationship (strong or medium direct dependence) also in the case of Greece, Romania, Bulgaria, Norway, Denmark, Lithuania, Ukraine, Croatia, Switzerland, and Slovakia. Surprisingly, there is a weak dependence in the Czech Republic, which ranks first in the number of km of railway lines per km² of its area from the studied countries. This can be caused by insufficient maintenance of railway lines but also by a significant change in the structure of the industry.

The results of the examination of the correlation between investments in railway infrastructure and transport performance in rail freight transport also show a statistically significant relationship in the case of the states of Denmark, Norway, the United Kingdom, and Luxembourg. In the case of Denmark and Norway, we observe a strong-to-medium direct dependence between the variables, which means that investment in infrastructure affects the performance of rail transport in the countries concerned.

The opposite case can be observed in the case of countries such as the United Kingdom, where we observe a medium indirect dependence, i.e., investment in infrastructure does

not affect the performance of rail freight transport. Especially in rail freight transport, it is not enough to build or reconstruct railway lines, but it is necessary to create additional conditions for the growth of rail freight transport: for example, the construction of railway sidings, the construction of combined transport terminals, access to the transport market and foreign carriers, and also, indirectly, greater regulation of road freight transport.

The results of the study of the correlation between the length of road infrastructure and transport performance in road freight transport show a statistically significant linear relationship in the case of Germany, Bulgaria, Poland, Hungary, Lithuania, Denmark, Slovakia, and the Czech Republic. The strength of a relationship ranges from strong to moderate direct dependence. It follows that the length of the infrastructure in the countries concerned affects the performance of road transport. It should be noted that these are transit countries through which main routes pass from east to west and from north to south of Europe.

In the case of the results of the study of the impact of road infrastructure investments on road freight transport performance, Germany has a strong direct dependence (correlation coefficient up to 0.99694), which is the largest transit country in Europe in addition to the strongest EU economy. There is also strong direct dependence in Bulgaria, which is a transit country mainly from Turkey and Greece, and Poland, which, in addition to its own growing economy, is the main transit country from East to West Europe and vice versa.

Weak direct dependence between investments in road infrastructure and transport performance in road freight transport is, e.g., in Croatia, which has invested heavily, especially in motorways. However, they are used mainly by passenger cars, and it is related to the support of tourism on the Adriatic Sea.

Given the focus of research on rail and road transport infrastructure, it would be interesting to examine only countries that do not have access to the sea and do not use this mode of transport for freight. However, the sample examined would be significantly reduced to the following countries: the Czech Republic, Luxembourg, Hungary, Austria, Slovakia, and Switzerland.

Statistical data on transport performance in tonne-kilometers are much more accurate for rail freight transport because they are obtained from all freight transport carriers; for example, there are only 25 of them in the Slovak Republic. There are more than 6000 carriers registered in road freight transport in the Slovak Republic, and only carriers with more than 20 employees are obliged to provide statistics. For others, a sample survey is performed, and statistics are calculated. Regulated cabotage is allowed within the EU. The point is that, for example, carriers from other Member States may perform up to three domestic transports on the territory of the Slovak Republic after international transport, and they enter the statistics of other states and not the statistics of the Slovak Republic. The numbers of these shipments are difficult to control, and therefore, the EU requires tachographs to enter domestic borders from 2 February 2022, and new digital tachographs from 2023 will record border crossings and (un)loading points without driver intervention. This creates a precondition for the refinement of data in statistics on the performance of domestic road freight transport.

The question of how investments in transport infrastructure affect the environment is also important for a sustainable green economy. For example, Reference [36] examines the interaction between VAT growth and investments in transport infrastructure, where the impact on rail infrastructure is not very significant but helps to build sustainable transport systems. Meanwhile, investments in road and air transport infrastructure have a negative impact on the environment. However, the research question requires a more comprehensive study because the structure of the vehicle fleet in road transport can be significantly changed in favor of the use of alternative fuels, and other elements from sustainable mobility plans can be employed, e.g., improving the quality of public passenger transport, bicycle transport, bike sharing, carsharing, the regulation of individual transport through the creation of low-emission zones, etc. The impacts of building road infrastructure on the environment can thereby be reduced. The relationship between urban transport

infrastructure in a sample of 280 cities in China and air quality according to the panel smooth-transition regression (PSTR) model is given in [37].

When examining the impact of transport infrastructure development on the performance of individual modes of transport and the impact on the environment, it is necessary to take into account the equipment of the transport infrastructure, especially charging stations and filling stations dedicated to alternative fuels. Partial results were published for Japan by Watabe et al. [38]. The aim of transport infrastructure development should be a sustainable transport system that meets the needs of the economy. Some proposals for a sustainable European transport system are published in [39]. The assessment of the effects of transport infrastructure on road freight transport performance also needs to include the provision of transport infrastructure with car parks and appropriate equipment for drivers' rest in accordance with social rules, which are still being tightened up [40].

Transport infrastructure development plans also need to transform transport investments into climate-resistant and low-carbon transport in order to achieve sustainable transport infrastructure.

The European Union is adopting a recovery plan to mitigate the effects of the COVID-19 pandemic on the economy. Slovakia, as an EU Member State, has submitted a plan in which €750 million is allocated for sustainable transport. This is mainly investments in railway repairs, the construction of cycle paths, the promotion of environmentally friendly public passenger transport, the promotion of intermodal transport, and the construction of charging stations for electric vehicles and hydrogen stations [41–43]. Similarly, other countries in the world are committed to investing in transport infrastructure, as described in [44]. Investment decisions need to have the greatest economic benefits but also help to reduce the environmental impact of transport.

It is generally argued, especially at the regional political level, that without transport infrastructure, no industry or other investment will come to a region. The European Commission is proposing to modernize cohesion policy in the next programming period 2021–2027. This is the EU's main investment policy and one of its most substantial expressions of solidarity. One of the goals of a modernized cohesion policy is to make Europe more connected to strategic transport and digital networks. The global COVID-19 pandemic and the preventive measures taken have significantly affected the mobility of the population and will have particular implications for sustainable urban mobility [45]. The construction of high-quality digital networks and their accessibility in the EU Member States would reduce the need for travel, i.e., the demand for the completion of transport infrastructure, especially for passenger cars. On the other hand, the need to transport goods, raw materials, etc., would not be affected; rather, it may gradually grow again. Thus, the need for transport infrastructure for freight transport is essential for the interconnection of regions and the international exchange of goods. The aim of this study was to use correlation analysis to compare selected parameters of the road and railway infrastructure of Japan and selected EU countries. A test of the significance of the correlation coefficient was also performed. Correlation analysis is not typical in the freight transport research published to date. Relative indicators comparing only the length of transport infrastructure relative to the area of the state and the population are inaccurate and can lead to distorted results. Therefore, we recommend using correlation analysis to examine the correlation between the performance of rail and road freight transport and infrastructure and the necessary infrastructure investments. For states with access to the sea and navigable rivers for inland freight transport, it is also necessary to examine the transport infrastructure for these modes of transport and their performance within the examined states, with especial consideration of aspects of ecology [46].

The decline in passenger air transport, especially on domestic airlines in EU countries due to the COVID-19 pandemic, and the promotion of sustainable mobility are leading to a reassessment of the need for domestic air transport. Some EU Member States (France, Germany, and Sweden) have declared that, even after the end of the COVID-19 pandemic, domestic air passenger transport between cities with good and fast rail connections will no

longer be resumed. The Czech Republic has announced plans to build a high-speed line between the three largest cities: Prague, Brno, and Ostrava. Therefore, larger investments in the construction of high-speed railway lines can be expected. However, the question arises as to whether this will be to the detriment of investment in rail transport infrastructure for the transport of goods. Due to the lack of funding for transport infrastructure and its possible redistribution in favor of rail passenger transport, investment in the renewal of rail freight sidings may be reduced in some EU countries. The railways needed to increase freight capacity and improve the availability of combined transport terminals, and seaports may therefore not receive sufficient financial support.

According to the EU White Paper on Transport, one of the main objectives is to triple the existing high-speed rail network by 2030 [47]. In the absence of funding and the current significant support for the construction of high-speed railways and the reduction of domestic air traffic, also due to the COVID-19 pandemic, this may lead to failure to meet EU targets for increasing rail freight transport.

Supplementary Materials: The following are available online at <https://www.mdpi.com/article/10.3390/su13126654/s1>, Table S1—Length of railway infrastructure of selected countries. Table S2—Length of road infrastructure of selected countries. Table S3—The performance of railroad transport in million tonne-kilometers. Table S4—The performance of road transport in million tonne-kilometers. Table S5—Amount of investment in road infrastructure in €. Table S6—Amount of investment in rail infrastructure in €.

Author Contributions: Introduction, J.G. and M.K.; literature review, J.G., Š.S. and M.K.; materials and methods, J.G., Š.S., M.B., M.K., R.C. and Z.Ř.; data curation, J.G., Š.S., R.C. and M.K.; results, J.G., Š.S., Z.Ř., and M.K.; writing—original draft J.G., Š.S., and M.K.; visualization, J.G., Š.S., M.B. and M.K. All authors have read and agreed to the published version of the manuscript.

Funding: This research was facilitated by support under the Operational Program Integrated Infrastructure for the following project: Identification and possibilities of implementation of new technological measures in transport to achieve safe mobility during a pandemic caused by COVID-19 (ITMS code: 313011AUX5), co-financed by the European Regional Development Fund.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Data is contained within the article or supplementary material. Therefore, the data were drawn from the Eurostat and Organisation for Economic Cooperation and Development (OECD) databases. However, not all data were available for all countries under the period studied. Therefore, the missing data were computed using trend curves based on moving averages.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Zhu, F.; Wu, X.; Gao, Y. Decomposition analysis of decoupling freight transport from economic growth in China. *Transp. Res. Part D Transp. Environ.* **2020**, *78*, 102201. [CrossRef]
2. Varjan, P.; Rovňaniková, D.; Gnap, J. Examining Changes in GDP on the Demand for Road Freight Transport. *Procedia Eng.* **2017**, *192*, 911–916. [CrossRef]
3. Ma, Y.; Zhu, J.; Gu, G.; Chen, K. Freight transportation and economic growth for zones: Sustainability and development strategy in China. *Sustainability* **2020**, *12*, 10450. [CrossRef]
4. Gnap, J.; Varjan, P.; Ďurana, P.; Kostrzewski, M. Research on relationship between freight transport and transport infrastructure in selected European countries. *Transp. Probl.* **2019**, *14*, 63–74. [CrossRef]
5. Grakhov, V.; Mohnachev, S.; Simakova, U.; Kislyakova, Y.; Saidova, Z.; Armanyan, A. Specific features of high-speed railway construction projects. *IOP Conf. Ser. Mater. Sci. Eng.* **2020**, *890*, 12214. [CrossRef]
6. Aswal, D.K. Quality Infrastructure of India and Its Importance for Inclusive National Growth. *Mapan J. Metrol. Soc. India* **2020**, *35*, 139–150. [CrossRef]
7. Rokicki, B.; Haddad, E.A.; Horridge, J.M.; Stepniak, M. Accessibility in the regional CGE framework: The effects of major transport infrastructure investments in Poland. *Transportation* **2020**, *48*, 747–772. [CrossRef]

8. He, S.; Yu, S.; Wang, L. The nexus of transport infrastructure and economic output in city-level China: A heterogeneous panel causality analysis. *Ann. Reg. Sci.* **2021**, *66*, 113–135. [CrossRef]
9. Cascetta, E.; Carteni, A.; Henke, I.; Pagliara, F. Economic growth, transport accessibility and regional equity impacts of high-speed railways in Italy: Ten years ex post evaluation and future perspectives. *Transp. Res. Part A Policy Pract.* **2020**, *139*, 412–428. [CrossRef]
10. Yetkiner, H.; Beyzatlar, M.A. The Granger-causality between wealth and transportation: A panel data approach. *Transp. Policy* **2020**, *97*, 19–25. [CrossRef]
11. Goldmann, K.; Wessel, J. TEN-T corridors—Stairway to heaven or highway to hell? *Transp. Res. Part A Policy Pract.* **2020**, *137*, 240–258. [CrossRef]
12. Skorobogatova, O.; Kuzmina-Merlino, I. Transport Infrastructure Development Performance. *Procedia Eng.* **2017**, *178*, 319–329. [CrossRef]
13. Torrisi, G. Public infrastructure: Definition, Classification and Measurement Issues. 2009. Available online: https://mpra.ub.uni-muenchen.de/12990/1/MPRA_paper_12990.pdf (accessed on 7 May 2021).
14. Dang, D.C.; Nguyen, D.B.; Trinh, T.H.; Banh, T.T.; Nguyen, T.T.C. The impact of ODA in constructing road traffic infrastructure on Vietnam's economic growth. *J. Proj. Manag.* **2021**, *6*, 99–106. [CrossRef]
15. Schumacher, K.; Chenet, H.; Volz, U. Sustainable finance in Japan. *J. Sustain. Financ. Investig.* **2020**, *10*, 213–246. [CrossRef]
16. Lorz, O. Investment in trade facilitating infrastructure: A political-economy analysis. *Eur. J. Polit. Econ.* **2020**, *65*, 101928. [CrossRef]
17. Baum-Snow, N.; Henderson, V.; Turner, M.A.; Zhang, Q.; Brandt, L. Does investment in national highways help or hurt hinterland city growth? *J. Urban Econ.* **2020**, *115*, 103124. [CrossRef]
18. Bond, E.W. Transportation infrastructure investments and trade liberalization. *Jpn. Econ. Rev.* **2006**, *57*, 483–500. [CrossRef]
19. Kowalski, M.; Wiśniewski, S. Transport Accessibility and Mobility: A Forecast of Changes in the Face of Planned Development of the Network of Expressways and Motorways in Poland. *Eur. Spat. Res. Policy* **2020**, *26*, 151–176. [CrossRef]
20. He, G.; Xie, Y.; Zhang, B. Expressways, GDP, and the environment: The case of China. *J. Dev. Econ.* **2020**, *145*, 102485. [CrossRef]
21. Anwar, A.; Sharif, A.; Fatima, S.; Ahmad, P.; Sinha, A.; Rehman Khan, S.A.; Jermisittiparsert, K. The asymmetric effect of public private partnership investment on transport CO₂ emission in China: Evidence from quantile ARDL approach. *J. Clean. Prod.* **2021**, *288*, 125282. [CrossRef]
22. Elburz, Z.; Cubukcu, K.M. Spatial effects of transport infrastructure on regional growth: The case of Turkey. *Spat. Inf. Res.* **2021**, *29*, 19–30. [CrossRef]
23. Liu, J.; Lu, H.; Chen, M.; Wang, J.; Zhang, Y. Macro perspective research on transportation safety: An empirical analysis of network characteristics and vulnerability. *Sustainability* **2020**, *12*, 6267. [CrossRef]
24. Li, B.; Gao, S.; Liang, Y.; Kang, Y.; Prestby, T.; Gao, Y.; Xiao, R. Estimation of Regional Economic Development Indicator from Transportation Network Analytics. *Sci. Rep.* **2020**, *10*, 2647. [CrossRef] [PubMed]
25. Tong, S. Research on the relationship between economic growth and road traffic infrastructure in Inner Mongolia. *IOP Conf. Ser. Earth Environ. Sci.* **2019**, *237*, 32135. [CrossRef]
26. Gasparik, J.; Dedik, M.; Cechovic, L.; Blaho, P. Estimation of transport potential in regional rail passenger transport by using the innovative mathematical-statistical gravity approach. *Sustainability* **2020**, *12*, 3821. [CrossRef]
27. Ližbetin, J. Methodology for Determining the Location of Intermodal Transport Terminals for the Development of Sustainable Transport Systems: A Case Study from Slovakia. *Sustainability* **2019**, *11*, 1230. [CrossRef]
28. Dolinayova, A.; Zitricky, V.; Cerna, L. Decision-making process in the case of insufficient rail capacity. *Sustainability* **2020**, *12*, 5023. [CrossRef]
29. Mašek, J.; Kendra, M.; Milinković, S.; Vesković, S.; Bárta, D. Proposal and application of methodology of revitalisation of regional railway track in Slovakia and Serbia. Part 1: Theoretical approach and proposal of methodology for revitalisation of regional railways. *Transp. Probl.* **2015**, *10*, 85–95. [CrossRef]
30. Stopka, O.; Chovancová, M.; Kampf, R. Proposal for streamlining the railway infrastructure capacity on the specific track section in the context of establishing an integrated transport system. *MATEC Web Conf.* **2017**, *134*, 55. [CrossRef]
31. Koks, E.E.; Rozenberg, J.; Zorn, C.; Tariverdi, M.; Voudoukas, M.; Fraser, S.A.; Hall, J.W.; Hallegatte, S. A global multi-hazard risk analysis of road and railway infrastructure assets. *Nat. Commun.* **2019**, *10*, 2677. [CrossRef] [PubMed]
32. Ližbetin, J.; Vejs, P.; Stopka, O.; Cempírek, V. The significance of dynamic detection of the railway vehicles weight [Značaj dinamičke detekcije težine željezničkih vozila]. *Nase More* **2016**, *63*, 156–160. [CrossRef]
33. Dolinayová, A.; Černá, L.; Hřebíček, Z.; Zitrický, V. Methodology for the tariff formation in railway freight transport. *Nase More* **2018**, *65*, 297–304. [CrossRef]
34. Poliak, M.; Šimurková, P.; Cheu, K. Wage inequality across the road transport sector within the EU. *Transp. Probl.* **2019**, *14*, 145–153. [CrossRef]
35. Kurosaki, F. A study of vertical separation in Japanese passenger railways. *Case Stud. Transp. Policy* **2018**, *6*, 391–399. [CrossRef]
36. Erdogan, S. Analyzing the environmental Kuznets curve hypothesis: The role of disaggregated transport infrastructure investments. *Sustain. Cities Soc.* **2020**, *61*, 102338. [CrossRef]
37. Guo, Y.; Zhang, Q.; Lai, K.K.; Zhang, Y.; Wang, S.; Zhang, W. The impact of urban transportation infrastructure on air quality. *Sustainability* **2020**, *12*, 5626. [CrossRef]

38. Watabe, A.; Leaver, J.; Ishida, H.; Shafiei, E. Impact of low emissions vehicles on reducing greenhouse gas emissions in Japan. *Energy Policy* **2019**, *130*, 227–242. [[CrossRef](#)]
39. García-Olivares, A.; Solé, J.; Samsó, R.; Ballabrera-Poy, J. Sustainable European transport system in a 100% renewable economy. *Sustainability* **2020**, *12*, 5091. [[CrossRef](#)]
40. Poliak, M.; Poliaková, A.; Čulík, K. Impact of the social law on truck parking sustainability in the EU. *Sustainability* **2020**, *12*, 9430. [[CrossRef](#)]
41. Ministry of Finance of the Slovak Republic. *Recovery and Resilience Plan of the Slovak Republic MF/007098/2021-2974*; Ministry of Finance of the Slovak Republic: Bratislava, Slovakia, 2021.
42. Skrúcaný, T.; Kendra, M.; Stopka, O.; Milojević, S.; Figlus, T.; Csiszár, C. Impact of the electric mobility implementation on the greenhouse gases production in Central European countries. *Sustainability* **2019**, *11*, 4948. [[CrossRef](#)]
43. Dižo, J.; Blatnický, M. Investigation of ride properties of a three-wheeled electric vehicle in terms of driving safety. *Transp. Res. Procedia* **2019**, *40*, 663–670. [[CrossRef](#)]
44. Lee, C.L.; Locke, M. The effectiveness of passive land value capture mechanisms in funding infrastructure. *J. Prop. Investig. Financ.* **2020**, *39*, 283–293. [[CrossRef](#)]
45. Newman, P. COVID, CITIES and CLIMATE: Historical Precedents and Potential Transitions for the New Economy. *Urban Sci.* **2020**, *4*, 32. [[CrossRef](#)]
46. Paulauskas, V.; Filina-Dawidowicz, L.; Paulauskas, D. The Method to Decrease Emissions from Ships in Port Areas. *Sustainability* **2020**, *12*, 4374. [[CrossRef](#)]
47. White Paper—Roadmap to a Single European Transport Area—Towards a Competitive and Resource Efficient Transport System. KOM (2011) 144, Brusel. 2011. Available online: <https://eur-lex.europa.eu/legal-content/SK/TXT/PDF/?uri=CELEX:52011DC0144&from=SK> (accessed on 6 June 2021).