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Multidimensional analysis of development of transport infrastructure and freight transport in the new EU member states

INTRODUCTION

The European Union's membership has grown over the last decade as new countries have acceded to an economic and political union and consequently they have become the part of common economic space and therefore obliged to respect the European transport policies. Even though, in some areas connected with transport the EU Member States are allowed to act independently, nevertheless the direction of development, transformation and adjustment within transportation and communication networks are to a high extent shaped and regulated by legal acts of the EU (such as regulations and directives), but also agreements between international organizations [16, p. 53]. It happens due to the fact that transport plays a remarkable role in an economic system. Undoubtedly, it is one of the most crucial factors contributing to economic development [5] and currently one of the most important economic sectors in the EU Member States³. Economic efficiency and the ability to take advantage of a single market depend heavily on smooth functioning of transport⁴. Another significant matter is that accessibility to modern transport infrastructure and its adequate capacity enable diffusion of economic growth from better developed countries to less developed ones [7]. Well developed transport infrastructure enhances social, economic and spatial integrity of countries and strengthens competition [6].

This paper provides both cognitive and didactic advantages. On one hand, its aim is to establish and describe the development of transport infrastructure and freight transport in the newer EU Member States in 2011 and consequently to indicate the countries where these two phenomena are in balance, and the countries with significant divergence between development of transport infrastructure and the size of freight transport. On the other hand, the idea standing behind this analysis is to show the process of forming synthetic measures and showing the advantages of multidimensional comparative analysis, which can be used in analyzing complex phenomena.

1. SCOPE OF DATA – METHODOLOGICAL NOTES

A multi-sector character of transport system is the reason why determining both development of transport infrastructure and freight transport requires using a few variables, which can describe these phenomena in a fragmentary way. Simultaneously, doing research in this specific multi-sector system demands applying measures, which allow to look at transport system synthetically. Taking into consideration these aspects, in the paper multidimensional comparative analysis methods have been applied. In order to get the most credible results not only one method has been used, but three of them, such as development model of Z. Hellwig, standardized sums and ranks.

The analysis of transport infrastructure development and freight transport by mentioned before methods started from establishing which newer EU Member States the research will concern. Two countries have not been taken into account (Cyprus and Malta) because some data was not available for these states. Thus, the research embraced 11 following countries: Bulgaria (BG), Croatia (HR), the

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³ In all EU Member States the value of passenger transport and freight transport is higher than GDP – in some countries even twofold.

⁴ In 2009 1,125.3 companies operated in transport sector in the EU. These companies, with turnover reaching €368,018 mln, employed 10,580.3 workers and freight transport accounted for 73% of their turnover [2].

Czech Republic (CZ), Estonia (EE), Hungary (HU), Lithuania (LT), Latvia (LV), Poland (PL), Romania (RO), Slovakia (SK), Slovenia (SI).

The next step concerned choosing the appropriate variables which can be used to characterize the mentioned phenomena in particular countries in 2011⁵. The variables have been selected from data available in the Internet and Eurostat (the statistical office of the European Union) publications⁶ on the basis of formal and professional criteria [17, p. 37]. It must be stated here that analysis has been limited to three types of transport: by road, rail and air. Transport by sea and inland waterways were not taken into consideration. The reason is that some of the countries subjected to the research do not have an opportunity to use sea transport because of their geographical location and transport by inland waterways is hardly ever used in analyzed states, except for two countries – Bulgaria and Romania. Consequently, with regard to transport infrastructure three variables have been made use of: X_{A1} – the length of the motorways network (km per 1,000 km²), X_{A2} – the length of the railways network (km per 1,000 km²), X_{A3} – the number of airports handling over 15,000 passengers annually (per 1,000,000 inhabitants). With respect to freight transport three variables have been applied as well: X_{B1} – the volume of freight transport by road (thousand tonnes per 1,000,000 inhabitants), X_{B2} – the volume of freight transport by rail (thousand tonnes per 1,000,000 inhabitants) and X_{B3} – the volume of freight transport by air (thousand tonnes per 1,000,000 inhabitants)⁷. All of the variables used in the analysis are stimulants and therefore it means that higher values indicate better development of transport infrastructure and bigger freight transport, and vice versa. The statistical description of chosen variables have been presented in table 1.

Tab. 1. The variables chosen to establish and describe the development of transport infrastructure and freight transport in the newer EU Member States and their basic statistics

Basic statistics	Transport infrastructure			Freight transport		
	X_{A1}	X_{A2}	X_{A3}	X_{B1}	X_{B2}	X_{B3}
Arithmetic mean	9,81	84,03	1,36	23 523,77	11 484,82	4,73
Smallest value of the variable	0,00	33,60	0,26	9 152,82	1 931,43	1,30
Largest value of the variable	37,88	198,64	5,25	36 786,74	36 271,13	13,75
Coefficient of variation	115,09%	57,11%	103,47%	37,05%	99,25%	75,04%

Source: Own elaboration on the basis of Eurostat data, <http://epp.eurostat.ec.europa.eu>

For the reason that the selected variables were expressed in different measurement units, there was a necessity to make them comparable through standardizing. The following standardized formula has been used:

$$z_{ij} = \frac{x_{ij} - \bar{x}_j}{s_j} \quad (1)$$

for $i = 1, 2, \dots, n$,

$j = 1, 2, \dots, m$,

where:

z_{ij} – standardized value of the j-variable in the i-country,

x_{ij} – empirical value of the j-variable in the i-country,

\bar{x}_j – arithmetic mean of the j-variable,

⁵ Selected variables are in the form of ratios – resigning absolute values is due to their little usefulness with respect to regional and demographic diversity of spatial units [15, s. 219].

⁶ Statistical data concerning transport in the EU is published, among others, in a periodical paper entitled *Energy, transport and environment indicators*. The aim of collecting this data by Eurostat is to monitor and develop common transport policy by the European Commission. The Commission also pays attention to regional transport and the Trans-European Transport Networks [1, p. 43].

⁷ Currently statistical data concerning freight transport by road, rail and air is submitted to Eurostat in accordance with (respectively): Regulation (EU) No 70/2012 of the European Parliament and of the Council of 18 January 2012 on statistical returns in respect of the carriage of goods by road Text with EEA relevance (Dz.U. WE L 032 z 3.02.2012 r.), Regulation (EC) No 91/2003 of the European Parliament and of the Council of 16 December 2002 on rail transport statistics (Dz.U. L 014 z 21.03.2003 r.), Regulation (EC) No 437/2003 of the European Parliament and of the Council of 27 February 2003 on statistical returns in respect of the carriage of passengers, freight and mail by air (Dz.U. L 066 z 11.03.2003 r.).

s_j – standard deviation of the j-variable,
 m – number of the variables,
 n – number of countries.

As a result of standardizing the values of the variables for the selected set of units (new EU Member States) the following standardized matrix has been created:

$$\begin{bmatrix} z_{11} & z_{12} & \dots & z_{1m} \\ z_{21} & z_{22} & \dots & z_{2m} \\ \dots & \dots & \dots & \dots \\ z_{n1} & z_{n2} & \dots & z_{nm} \end{bmatrix} \quad (2)$$

which has become the starting point for forming (by means of two methods: development model of Z. Hellwig and standardized sums) synthetic measures describing development of transport infrastructure and freight transport in particular countries⁸.

1.1. Development model of Z. Hellwig⁹

The standardized matrix (2) has become the basis for determining a model country with coordinates in the form of a vector:

$$z_0 = [z_{01}, z_{02}, \dots, z_{0m}] \quad (3)$$

described by the following relation $z_{0j} = \max_i \{z_{ij}\}$ because all the variables are stimulants¹⁰.

Next, the distance of each country to a model country has been calculated making use of Euclidean formula:

$$D_{i0} = \sqrt{\sum_{j=1}^m (z_{ij} - z_{0j})^2} \quad (4)$$

for $i = 1, 2, \dots, n$.

The obtained values D_{i0} meant a delay of i-country in relations to a model country with regard to development of transport infrastructure and freight transport. The synthetic measures of development of transport infrastructure and freight transport for each state have been finally calculated by the following formula:

$$d_i = 1 - \frac{D_{i0}}{D_0} \quad (5)$$

for $i = 1, 2, \dots, n$,

where:

$$D_0 = \overline{D}_0 + 2s_0 ,$$

whereas:

\overline{D}_0 – mean value of the calculated distances D_{i0} ,

s_0 – standard deviation of the calculated distances D_{i0} .

The created measures have taken values from the interval $<0;1>$ where the higher value indicated better development of transport infrastructure and larger freight transport, on the other hand, lower value meant that the country's development of transport infrastructure was worse and transport of goods was smaller.

⁸ Standardized ranks method is not used for standardizing features.

⁹ Development model of Z. Hellwig is one of the most often used multidimensional comparative methods and simultaneously used as a model and a prototype for other measures [4].

¹⁰ In case of using destimulants the following relation $z_{0j} = \min_i \{z_{ij}\}$ should be used.

1.2. Method of standardized sums

The standardized matrix (2) allowed to calculate arithmetic means from standardized values of variables for each country using the following formula [13]:

$$\bar{z}_i = \frac{1}{m} \sum_{j=1}^m z_{ij} \quad (6)$$

for $i = 1, 2, \dots, n$,

where:

z_{ij} – standardized value of the j-variable in the i-country,

m – number of the variables.

Higher values of means stood for better development of transport infrastructure and bigger freight transport whereas lower values indicated worse development of transport infrastructure and smaller transport of goods.

1.3. Method of ranks

The newer EU Member States were put in a descending order according to the values of the variables and afterwards each country was assigned a rank, namely a successive natural number from 1 to n , starting from the country with the highest variable¹¹. This procedure enabled to calculate arithmetic means from the values of ranks for each state using the following formula [14]:

$$\bar{w}_i = \frac{1}{m} \sum_{j=1}^m w_{ij} \quad (7)$$

for $i = 1, 2, \dots, n$,

where:

w_{ij} – rank of j-variable in i-country,

m – number of the variables.

Unlike the standardized sums method, higher values of means indicated worse development of transport infrastructure and smaller freight transport in a particular country whereas lower values meant that country's development of transport infrastructure was better and transport of goods larger.

2. PRESENTATION OF RESEARCH RESULTS

On the basis of selected variables which have been treated as equivalent¹² (having the same importance) and acting on the procedure described before in this paper, synthetic measures of transport structure development and of freight transport have been calculated. Eventually, the obtained values of these measures allowed to put the newer EU Member States in a certain order, from 'the best' to 'the worst' ones with regard to development of transport infrastructure and goods transport. The results of ranking have been presented in tables 2 and 3 (columns „position”).

¹¹ In the case of making use of destimulants, the countries should be put in an ascending order according to the value of certain diagnostic variables and then each state should be assigned a rank, a successive natural number from 1 to n , starting from the country with the lowest variable.

¹² Assigning the same scales is often used in practice by professionals involved in estimating the level of socio-economic development of spatial units [3].

Tab. 2. Synthetic measures of transport infrastructure development in the newer EU Member States

Country	Development model of Z. Hellwig		Method of standardized sums		Method of ranks	
	d_i	position	\bar{z}_i	position	\bar{w}_i	position
Bulgaria	0,0969	11	-0,5941	11	7,3333	9
Croatia	0,3482	2	0,3494	4	4,0000	2
Czech Republic	0,2983	3	0,5718	2	4,6667	3
Estonia	0,2647	4	0,4559	3	6,3333	6
Hungary	0,2533	5	0,0156	5	5,0000	4
Lithuania	0,1193	9	-0,5066	10	7,3333	8
Latvia	0,1139	10	-0,4973	9	7,6667	10
Poland	0,1798	7	-0,1876	7	7,0000	7
Romania	0,1275	8	-0,4573	8	8,3333	11
Slovakia	0,2201	6	-0,1640	6	5,6667	5
Slovenia	0,4534	1	1,0143	1	2,6667	1

Source: Own elaboration on the basis of Eurostat data, <http://epp.eurostat.ec.europa.eu>

Tab. 3. Synthetic measures of freight transport in the newer EU Member States

Kraj	Development model of Z. Hellwig		Method of standardized sums		Method of ranks	
	d_i	position	\bar{z}_i	position	\bar{w}_i	position
Bulgaria	0,2299	9	-0,6365	9	8,6667	9
Croatia	0,1897	10	-0,7732	10	9,6667	10
Czech Republic	0,4818	3	0,4516	3	3,3333	2
Estonia	0,7753	1	1,6152	1	2,3333	1
Hungary	0,3577	5	-0,1861	7	6,0000	5
Lithuania	0,3284	7	-0,2625	8	6,6667	8
Latvia	0,5715	2	0,7094	2	3,3333	3
Poland	0,3082	8	-0,0126	5	6,0000	6
Romania	0,1018	11	-1,1192	11	10,3333	11
Slovakia	0,3545	6	-0,1475	6	6,0000	7
Slovenia	0,4103	4	0,3614	4	3,6667	4

Source: Own elaboration on the basis of Eurostat data, <http://epp.eurostat.ec.europa.eu>

The obtained values of synthetic measures show significant differences between the newer EU Member States, as concerned both, development of transport infrastructure and freight transport. The results of calculations received by three independent methods show unambiguously that transport infrastructure is best developed in Slovenia, Croatia and the Czech Republic, whereas the worst in Bulgaria and Latvia. With respect to freight transport, relatively the best situation takes place in Estonia, the Czech Republic and Latvia and the most unfavorable in Romania and Croatia. Comparing positions of remaining countries by development model of Z. Hellwig and standardized sums and ranks, it can be observed that they differ slightly – generally the divergence does not exceed three positions in plus or in minus in the presented ranking. A high degree of coherence of received results

is validated by the value of Spearman's rank correlation coefficient presented in table 4, which has been calculated in the following way¹³:

$$r_s = 1 - \frac{6 \sum_{i=1}^n d_i^2}{n(n^2 - 1)} \quad (8)$$

where:

d_i – differences between ranks of (positions) countries,
 n – number of countries.

Tab. 4. The coherence of positions of the new EU Member States with regard to development of transport infrastructure and freight transport

Specification	Spearman's rank correlation coefficient	
	Development of transport infrastructure	Freight transport
Development model of Z. Hellwig / Method of standardized sums	0,964	0,936
Development model of Z. Hellwig / Method of ranks	0,909	0,964
Method of standardized sums / Method of ranks	0,845	0,964

Source: Own elaboration on the basis of Eurostat data, <http://epp.eurostat.ec.europa.eu>

3. ANALYSIS OF RESEARCH RESULTS

Possessing the information concerning positions of particular countries with respect to development of transport infrastructure (table 2) and freight transport (table 3) an arithmetic mean from the three positions for each country (\bar{p}_i) has been calculated (separately for development of transport infrastructure and goods transport) and afterwards the countries have been divided into four groups embracing units with values \bar{p}_i from the following intervals¹⁴:

- group A / group 1: $\bar{p}_i < \bar{p}_i - s_p$
- group B / group 2: $\bar{p}_i > \bar{p}_i \geq \bar{p}_i - s_p$
- group C / group 3: $\bar{p}_i + s_p > \bar{p}_i \geq \bar{p}_i$
- group D / group 4: $\bar{p}_i \geq \bar{p}_i + s_p$

where:

\bar{p}_i – arithmetic mean calculated for the value \bar{p}_i ,

s_p – standard deviation calculated for the value \bar{p}_i .

With regard to development of transport infrastructure three, mentioned before, countries – Slovenia, Croatia and the Czech Republic belong to group A. In group B there are states (Estonia, Hungary, Slovakia) in which transport infrastructure is developed quite well. Group C consists of countries where transport infrastructure is poorly developed (Poland, Romania, Lithuania). Bulgaria and Latvia belong to group D and these are the states where infrastructure is the least expanded. As far

¹³ Spearman's rank correlation coefficient takes values from the interval <-1;1>. The closer the absolute value of Spearman's rho to 1, the better the coherence of countries' positions is [9, s. 233].

¹⁴ Groups marked with letters concern development of transport infrastructure and those with numbers regard freight transport. In the calculations the classification method of E. Nowak has been applied yet reversing the signs in the inequalities has been used as lower values have been more desirable, meaning better development of transport infrastructure and higher freight transport [8, s. 93].

as freight transport is concerned, in group 1 there are three countries mentioned before – Estonia, the Czech Republic and Latvia. Countries (Slovenia, Hungary) with the size of freight transport higher than the average for all new EU Member States belong to group 2. Group 3 consists of countries (Slovakia, Poland, Lithuania and Bulgaria) where the amount of goods transport is lower than the average. In group 4 there are states (Romania and Croatia) with the lowest freight transport. The mean values of the variables in particular groups have been presented in table 5.

Tab. 5. The mean values of the variables in particular groups of countries figured out with respect to development of transport infrastructure and freight transport

Group	Transport infrastructure			Freight transport		
	\bar{x}_{A1}	\bar{x}_{A2}	\bar{x}_{A3}	\bar{x}_{B1}	\bar{x}_{B2}	\bar{x}_{B3}
A / 1	23,12	126,16	1,19	28 100,22	24 534,49	8,66
B / 2	8,28	73,76	2,29	27 597,98	6 528,55	5,55
C / 3	3,22	80,02	0,68	25 777,11	5 490,15	2,85
D / 4	2,05	42,23	1,25	13 306,21	2 889,92	1,49

Source: Own elaboration on the basis of Eurostat data, <http://epp.eurostat.ec.europa.eu>

Analyzing the development of transport infrastructure it can be stated that countries from group A are mainly characterized by advanced motorways network and developed railways network. In states belonging to group B the motorways network is quite well expanded and there is a very good airports network. Poorly developed motorways and airports networks and quite expanded railways network are characteristic of countries from group C. The amount of airports is relatively high in states belonging to group D, but the motorways and railways networks are badly developed there. Taking into account transport of goods, it can be observed that countries from group 1 are characterized by a big amount of transport by rail and air. The size of transport by road and air is quite significant in countries belonging to group 2. Group 3 consists of states with quite big transport by road and in countries belonging to group 4 freight transport, no matter what means of transport are taken into consideration, is relatively low.

On the basis of depicted typology of the new EU Member States with regard to development of transport infrastructure and freight transport, an attempt can be made to point out the countries in which the relation between analyzed phenomena seems to be the most balanced and the states where there is a significant divergence between transport infrastructure development and the size of goods transport. Undoubtedly, the countries from groups A1, B2 and C3 belong to the first category and in contrast there are the states from the outermost groups A4 and D1. Thus, the countries with a well-balanced relation are the Czech Republic, Hungary, Poland and Lithuania. All things considered, the size of freight transport in these countries is proportionate to development of transport infrastructure. By contrast, the states with the unbalanced proportion are Croatia and Latvia. As far as Croatia is concerned, well developed transport infrastructure, especially motorways network, is not accompanied by the significant size of freight transport (divergence in plus). This situation should not seem unexpected as Croatia is the country in which economy is largely based on tourism, not industry. In the case of Latvia, poorly developed transport infrastructure (lack of motorways) is accompanied by quite high amount of freight transport, especially by rail (divergence in minus). Described relations have been presented in figure 1.

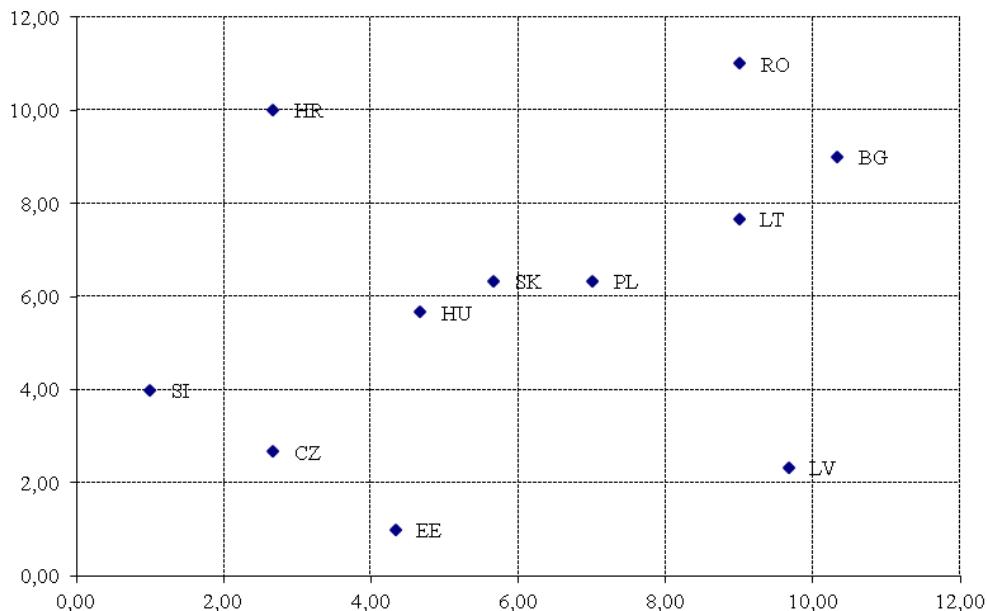


Fig. 1. The positions of the new EU Member States with regard to development of transport infrastructure (horizontal axis) and freight transport (vertical axis)

Source: Own elaboration on the basis of Eurostat data, <http://epp.eurostat.ec.europa.eu>

The conducted analysis has been supplemented with measuring the impact of the particular variables on development of transport infrastructure and freight transport. Therefore, Pearson's Product-Moment Correlation Coefficients have been calculated between the values of the variables selected for measurement and the values of the synthetic measures using the following formula¹⁵:

$$r_{xy} = \frac{\sum_{i=1}^n (x_i - \bar{x})(y_i - \bar{y})}{n \cdot s(x) \cdot s(y)} \quad (9)$$

where:

- x_i – value of the variable x,
- y_i – value of the variable y,
- \bar{x} – arithmetic mean of the variable x,
- \bar{y} – arithmetic mean of the variable y,
- $s(x)$ – standard deviation of the variable x,
- $s(y)$ – standard deviation of the variable y,
- n – number of countries.

¹⁵ Pearson's Product-Moment Correlation Coefficient takes values from the interval <-1;1>. If the correlation coefficient takes values closer to 1 or -1, the correlation is stronger [18, s. 63].

Tab. 6. The impact of the values of the variables on the values of the synthetic measures (absolute values of Pearson's Product-Moment Correlation Coefficient)

Synthetic measure	Transport infrastructure			Freight transport		
	X _{A1}	X _{A2}	X _{A3}	X _{B1}	X _{B2}	X _{B3}
d _i	0,880	0,459	0,191	0,494	0,868	0,899
z̄ _i	0,756	0,525	0,310	0,599	0,833	0,858
w̄ _i	0,907	0,459	0,034	0,732	0,689	0,738

Source: Own elaboration on the basis of Eurostat data, <http://epp.eurostat.ec.europa.eu>.

The obtained results indicate that development of transport infrastructure is largely determined by the length of the motorways and the least by the number of airports. In addition, diversity of the magnitude of freight transport is mostly influenced by the size of transport by rail and air, a bit less by transport by road.

CONCLUSIONS

The conducted analysis of spatial diversity of transport infrastructure development and freight transport in the new EU Member States allows to arrive at three crucial conclusions. First of all, all applied multidimensional comparative analysis methods indicate that transport infrastructure is best developed in Slovenia, whereas freight transport is relatively the highest in Estonia. Secondly, the Czech Republic, Hungary, Poland and Lithuania are the countries where the proportion between the amount of freight transport and development of transport infrastructure is well-balanced, while in other countries like Croatia (divergence in plus) and Latvia (divergence in minus) is unbalanced. Thirdly, development of transport infrastructure depends mostly on the length of motorways, whereas disproportions concerning freight transport are determined, above all, by the amount of rail freight and air freight.

Summing up, it must be explicitly pointed out that the results of the research must be treated with cautious. The research has solely been based on public, open-access information provided by Eurostat, which were comparable for particular countries. Thereby, in the analysis some aspects connected with the condition of transport infrastructure (e.g. the quality of railways, airport facilities) and the number and quality of means of transport used in particular countries have not been taken into account. It should be mentioned here that in socio-economic research concerning territorial units generally a compromise must be reached between what the researchers would like to take into consideration while analyzing a certain phenomenon and what data is available in that domain. In the authors' opinion the overall picture of transport infrastructure and freight transport in the new EU Member States has been caught. The results of the conducted research can become a starting point for economic optimization and beneficial while taking strategic decisions.

Abstract

The main purpose of this article is to establish and describe the development of transport infrastructure and freight transport in the new EU Member States making use of three multidimensional comparative analysis methods. Taking into account that transport is one of the most crucial factors contributing to economic development, it should be assumed that knowledge about diversity of transport system development in particular countries can become a starting point for economic optimization and therefore can be applicable while taking important strategic decisions.

The outcomes of the research conducted by three independent methods such as development model of Z. Hellwig, standardized sums and ranks allow to arrive at the following conclusions. The best developed transport infrastructure can be observed in Slovenia, whereas transport of goods is relatively the highest in Estonia. The calculations which have been done also indicate that the proportion between the amount of freight transport and development of transport infrastructure is well-balanced in the Czech Republic, Hungary, Poland and Lithuania whereas in other states like Croatia (divergence in plus) and Latvia (divergence in minus) is unbalanced. Moreover, the results of the analysis allow to draw a conclusion that development of

transport infrastructure depends mostly on the length of motorways, whereas disproportions with regard to goods transport are determined, above all, by size of rail freight and air freight.

Wielowymiarowa analiza rozwoju infrastruktury transportowej i transportu towarowego w nowych krajach członkowskich Unii Europejskiej

Streszczenie

Zasadniczym celem niniejszego artykułu jest ustalenie, za pomocą trzech metod wielowymiarowej analizy porównawczej, rozwoju infrastruktury transportowej i transportu towarowego w nowych krajach członkowskich UE. Biorąc bowiem pod uwagę fakt, iż transport jest jednym z niezwykle istotnych czynników rozwoju gospodarczego należy przypuszczać, że wiedza na temat dysproporcji rozwoju systemów transportowych w poszczególnych krajach może stanowić punkt wyjścia do optymalizacji procesów gospodarczych i rozstrzygnąć na etapie podejmowania strategicznych decyzji

Rezultaty analizy przeprowadzonej trzema niezależnymi metodami tj. metodą wzorca rozwoju Z. Hellwiga, metodą sum standaryzowanych i metodą rang pozwalają stwierdzić, że infrastruktura transportowa jest najlepiej rozwinięta na Słowenii, natomiast transport towarowy jest relatywnie największy w Estonii. Dokonane obliczenia wskazują również, że krajami, w których relacja między wielkością transportu towarowego a rozwojem infrastruktury transportowej jest najbardziej zrównoważona są Czechy, Węgry, Polska i Litwa. Z kolei krajami, w których powyższa relacja jest zachwiana są Chorwacja (rozbieżność in plus) i Łotwa (rozbieżność in minus). Ponadto wyniki analizy pozwalają wysunąć wniosek, iż rozwój infrastruktury transportowej w największym stopniu zależy od długości autostrad, natomiast dysproporcje transportu towarowego są zdeterminowane przede wszystkim wielkością transportu lotniczego i kolejowego.

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