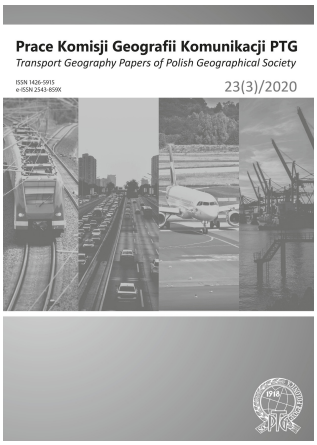

Transport Geography Papers of Polish Geographical Society

2020, 23(3), 41-60

DOI 10.4467/2543859XPKG.20.019.12787

Received (Otrzymano): 20.02.2020
Received in revised form (Otrzymano poprawioną wersję): 21.05.2020
Accepted (Zaakceptowano): 22.05.2020
Published (Opublikowano): 30.06.2020

EXPANDING THE NETWORK OF HIGHWAYS AND EXPRESSWAYS IN THE POST-SOCIALIST COUNTRIES OF THE EUROPEAN UNION IN THE YEARS 2004–2019

Rozbudowa sieci autostrad i dróg ekspresowych postsocjalistycznych państwach Unii Europejskiej w latach 2004-2019

Stanisław M. Koziarski

Institute of Socio-Economic Geography and Spatial Management, University of Opole, ul. Ozimska 46a 45-058 Opole
e-mail: stanislaw.koziarski@uni.opole.pl

Citation:
Koziarski S., 2020, Expanding the network of highways and expressways in the post-socialist countries of the European Union in the years 2004–2019, *Prace Komisji Geografii Komunikacji PTG*, 23(3), 41–60.

Abstract. The aim of this article is to analyze the pace of expansion of the network of highways and expressways over the past 15 years of membership in the European Union. Joining the European Union by such post-socialist countries as: Poland, Lithuania, Latvia, Estonia, the Czech Republic, Slovakia, Hungary, Slovenia (2004), Bulgaria, Romania (2007) and Croatia (2013) as well as the funds received for the development of transport infrastructure significantly contributed to the boom in the pace of road investments in these countries. The existing networks of highways and expressways in the 11 analyzed countries are at the stage of creating major national and international connections. The most advanced expansion of the national highway system is taking place in Poland and Hungary. Stable development, with a slight annual growth of the length of new highways, is taking place in Bulgaria, Croatia, the Czech Republic, Romania, Slovakia and Slovenia. Stagnation in the development of roads of this type is occurring in Lithuania, Latvia and Estonia. Toll roads are operated in 8 out of 11 analyzed countries. The vignette system for highways is used in Bulgaria, the Czech Republic, Slovakia, Slovenia, Romania and Hungary. Toll is paid at tollbooths in Croatia and Poland. Most of the highways in Central Europe are concentrated around the capital agglomerations, e.g. Budapest, Prague, Bratislava, Ljubljana, Zagreb, Sofia and Bucharest, with the exception of Warsaw, which is slowly rebuilding its central position in the network of expressways (A-2, S-7, S-8, S-17) in Poland. The first sections of highways in the discussed countries, except for Poland, were located around the capital cities. The layout of the highway network is often determined by the orography of the terrain, especially the course of mountain ranges, great rivers and coasts. Due to the varied topography, costs are rising, and the construction time of engineering structures such as tunnels, overpasses and bridges is longer, with countries such as Croatia, Slovenia, Slovakia, and recently also the Czech Republic, Poland and Romania being forced to build them.

Keywords: transport, post-socialist EU countries, highways, expressways

1. Introduction

The aim of the article is to present the state of development of the network of highways and expressways in the post-socialist countries of the European Union. The analysis of the development processes of this type of transport networks has usually focused on countries with an extensive network of such roads, such as Germany, Italy, France, Great Britain and Spain, located in the southwestern part of Europe. Previous studies have focused on the analysis of selected countries, and there was no comprehensive comparative view in this regard documented by available publications. This study attempts to answer the question about the pace and spatial directions of the expansion of highway connections in the Central and Eastern part of Europe. A noticeable increase in the length of express roads and highways commissioned in Poland was a definite incentive for the aforementioned comparative analyses. At the time of joining the EU, some of the analyzed countries, such as the Czech Republic and Hungary, already had a partially built network of highways and extensive experience in preparation and implementation of large infrastructural investments. The collected basic and verified numerical data and the maps of expressway network systems updated by the author show the degree of implementation of investment plans in the field of creating a pan-European highway system.

Originally, this article had a much larger form. The previously prepared material separately presented each of the 11 analyzed post-socialist countries. Due to the limited publishing framework, the article was shortened by the author, and redundant descriptions were removed; however, an attempt was made to include its content in the attached figures presenting both numerical data and spatial layouts of the network of highways and expressways in individual countries.

2. Literature review

This article was inspired by a series of publications by E. Cialone, A. Saccone (1999), which appeared yearly in the period of 1989–1999 in the Italian specialist journal *Autostrade*. The subject matter of the abovementioned articles concerned changes in the highway network, mainly in Western European countries, because roads of this type were mainly built there at that time. This article aims to present the process of expanding the network of expressways in the eastern part of Europe, where post-socialist countries had to make up for the last 30 years' delays in shaping modern road infrastructure of significant capacity.

The subject of highways had appeared the earliest in the literature of countries that had been intensively developing a network of road connections of this type. Initially, these were mainly technical, less spatial, studies which appeared in the interwar period in Italy, then in Germany, after 1945 in the USA, and later also in Great Britain, France, the Netherlands, Japan and Spain, and recently also in China. Research needs in the field of motorway construction were quickly reflected in the publishing market. There were new publications narrowing the subject matter only to roads. Namely, in English these are, among others, journals *Highways* and *World Highways*, in German, among others: *Strasse + Autobahn* and *Strasse und Verkehr*, in French: *Autoroute*, in Italian: the aforementioned *Autostrade* (now *Le Strade*), or also in Polish, among others: *Drogownictwo*, *Polskie Drogi*, *Magazyn Autostrada* and *Przegląd Komunikacyjny*, also covering other modes of transport.

A contemporary reminiscence of studies regarding highways are anniversary articles summarizing the expansion of the network of expressways, such as examples of articles on the development of highways in Germany (R. Fielenbach, H. Firk, 1992) or Great Britain (B. Kent, 2019) listed in references.

The classic foundations of the theory of transport geography in world literature, including roads, can be found in collective works, among others by E.J. Taaffe, H.L. Gauthier (1996) and J.-P. Rodrigue (2006). The leading research center in Poland in the field of transport geography is the Institute of Geography and Spatial Planning of the Polish Academy of Sciences in Warsaw, mainly due to such research authorities as Professors S. Berezowski, T. Lijewski and Z. Taylor. The theoretical and methodological foundations for the study of transport networks, including expressways, can be found in the unfortunately never republished textbook publication by Z. Taylor and M. Potrykowski (1982) *Geografia transportu. Zarys problemów, modeli i metod badawczych* [Eng.: *Transport geography. An outline of problems, models and research methods*]. This research is consistently continued at the Institute, among others, in the context of accessibility, mobility, traffic modeling and is reflected in numerous other collective or individual studies, among others, by Z. Taylor and A. Ciechański (2017, 2018), T. Komornicki (1995, 2013, 2015, 2018), P. Śleszyński (2013, 2015, 2018) and P. Rosik (2012, 2013, 2015, 2018). Elements of the methodology and selected research tools, also useful in the analysis of the geography of transport, can be found in Prof. Jerzy Runge's book (2007) compiling research methods used in socio-economic geography.

In Poland, wider attempts to present the highway-related issues took place during the annual in-

ternational "cross-border" conferences organized in Polańczyk, Sanok and Arłamów by Prof. Jerzy Kitowski from the University of Rzeszów in 1992–2008, which proved to be the largest forum for the exchange of geopolitical and transport ideas in Poland. These 16 conferences resulted in extensive volumes of post-conference materials, which eventually turned into the present *Transport Geography Papers of PGS (Prace Komisji Geografii Komunikacji PTG)*, in which the next generation of researchers from university centers in Krakow, Poznań, Gdańsk, Łódź, Wrocław, Sosnowiec, Lublin and Szczecin who deal with transport issues publishes their studies.

The Institute of Geography at Gdańsk University has become an important national center where research on individual branches of land and sea transport is conducted. The issues of transport, including road transport, can be found in the studies of, among others, T. Palmowski (2013) and M. Połom (2017). The geopolitical aspects of transit in the countries of Central Europe are included in an extensive study by J. Wendt (1999). It is at Gdańsk University that since 2016, after a several years' break, *Transport Geography Papers of PGS (Prace Komisji Geografii Komunikacji PTG)*, edited by the aforementioned Dr. Marcin Połom, have been published in an attractive changed layout.

Original attempts to research the spatial development of the highway network in the world, including the countries of Central Europe, can also be found in an extensive monograph by S. Koziarski (2004) published by the University of Opole, while the current directions of development of the network of highways and expressways in Poland are presented in the author's study published in 2018 in *Transport Geography Papers of PGS (Prace Komisji Geografii Komunikacji PTG)*.

3. The development of highways in post-socialist countries

This article presents a comparative study of the development of the highway network in the post-socialist countries, which joined the European Union in three stages. These were Poland, the Czech Republic, Slovakia, Hungary, Lithuania, Latvia and Estonia in 2004, Bulgaria and Romania in 2007, and Croatia in 2013. At the time of accession, the countries in question had a comparable length of the highway network, and the last 15 years of network expansion have brought about significant changes in its pace. In the development of the road network in question, the EU financial support related to the leveling of differences in the development of transport infrastructure began to play a decisive role. The scale of infrastructural investments is also related to the prepared transport projects, the countries' own financial participation, the efficiency of the tender procedures and companies ultimately completing construction projects, and as regards the latter, the situation has been different over the past 15 years.

Analysis of statistical data (fig. 1) concerning the network of expressways in the discussed 11 post-

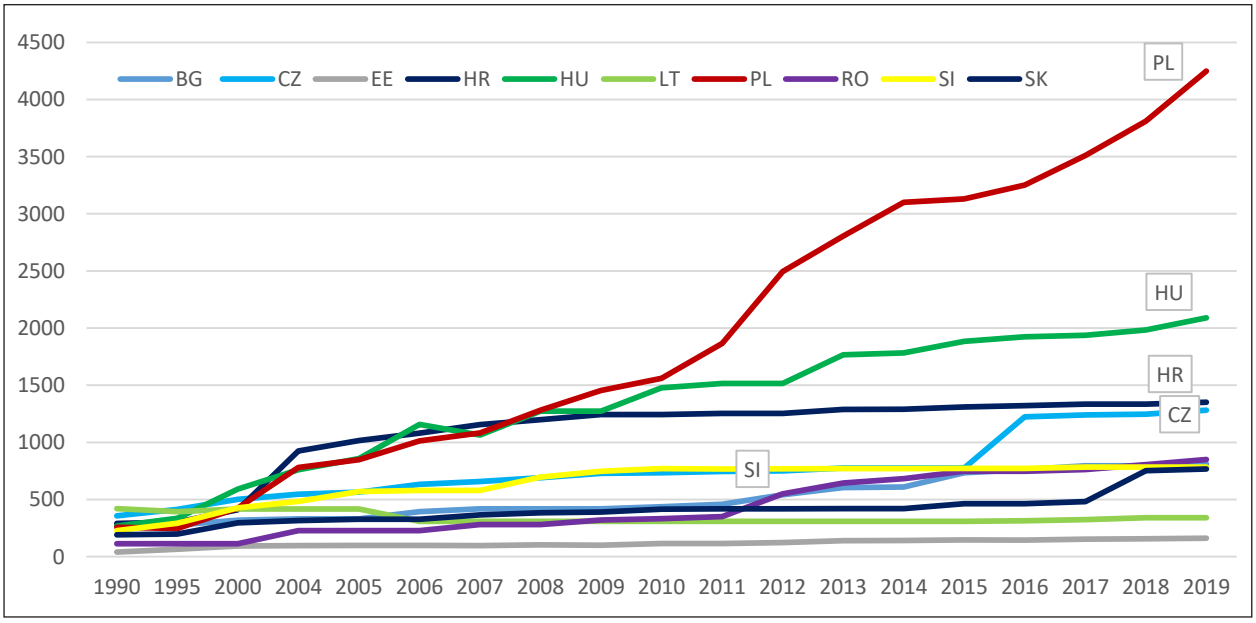

Fig. 1. Development of the network of highways and expressways in the post-socialist EU countries

Note: BG – Bulgaria, CZ – Czech Republic, EE – Estonia, HR – Croatia, LT – Lithuania, HU – Hungary, PL – Poland, RO – Romania, SI – Slovenia, SK – Slovakia.

Source: own elaboration based on data from Table 2.

socialist countries enabled distinguishing three groups of countries that differ in terms of the pace of an increase in the length of these routes. Thus, the first group has a stagnant length of the network (Lithuania, Latvia, Estonia); the second group of countries has a recently stable but slight annual increase in the network length (Bulgaria, the Czech Republic, Croatia, Romania, Slovakia and Slovenia), and the third group comprises countries that are dynamically developing this type of main roads (Poland, Hungary). This breakdown is not unambiguous and definite, as the analyzed countries in the past also had periods of intense growth, or stagnation or regression in transport investments. Some countries, such as Slovenia or partly Croatia, have already completed most of their network development plans, hence the limited pace of growth. Undoubtedly, however, an unequivocal conclusion should be drawn: accession to the EU and funds for the development of transport infrastructure had a decisive impact on the acceleration of the pace of investment in expressways in the discussed countries. Poland is the unquestionable leader in this ranking, as in the past 15 years since its accession to the EU, it has experienced a certain "boom" in road construction, comparable to the best years of building such routes, e.g. in Germany, Spain or France. This is confirmed, among others, by record-breaking lengths of newly opened highways and expressways, for example, in 2012 – 650 km and in 2019 – 412 km. Substantial annual increases in newly-opened roads have put Poland in the group of EU countries with a significant length of the highway network, ahead of, among others, Great Britain. Hence, Poland already ranks 5th in the EU, after Spain, France, Germany and Italy. A similar "jump" in the development of transport infrastructure was achieved earlier by Germany, Italy, France, and recently Spain, where the very good pace of implementation of transport investments has been maintained until now.

The post-socialist countries of Central Europe have a sufficiently developed road network. However, the construction of transit roads with the parameters of highways or expressways is of paramount importance, especially for long-distance traffic, including cross-border traffic. For the purposes of this study, the terms highway and expressway are treated equally and are used interchangeably, although there are significant technical differences between them. The basic differences include the number of collision-free junctions and their frequency, the number of lanes (usually 2 x 2 and more), the radius of curves and the associated speed limit. The prerequisite to qualify a road to the network of expressways was separating the lanes for both traffic directions and the non-collision course of their routes. The first roads with highway parameters were built already in the 1960s and 1970s in the today Czech Republic and Hungary, and later in Slovakia, Poland, Slovenia, Croatia, Bulgaria and Romania (fig. 2).

The historical development of the network of expressways varied in the analyzed countries. For example, in the areas of Silesia and Pomerania taken over from Germany, Poland inherited approx. 200 km of old highways heading, among others, from Wrocław and Szczecin to Berlin. During the communist period, especially in the 1970s, the first highways were built in Hungary (M-7 highway connecting the country's capital, Budapest, with the towns on Lake Balaton), in the then federal Czechoslovakia (D-1 highway, Prague – Brno – Bratislava, connecting the capitals of both countries), in federal Yugoslavia, where construction of a transit trunk route connecting the capitals of the state republics Ljubljana (Slovenia) – Zagreb (Croatia) – Belgrade (Serbia) was started, in Bulgaria (exit roads from the capital of Sofia and an access route to the airport in the Varna region) and in Romania (A-1 on the section Bucharest – Pitesti). In the 1980s, mainly due to the progressing economic crisis affecting individual socialist countries, a few short sections of highways were built, e.g. in Poland: A-4 between Krakow and Trzebinia, in Czechoslovakia: exit sections of expressways in the area of Prague (D-11), Bratislava (present D-1) and Brno, and in Hungary, where the construction of exit roads from the capital of the country was continued (M-1 Budapest – Tatabánya – Győr and M-3 Budapest – Hatvan). The collapse of the socialist system and economic transformations in the early 1990s were also not conducive to the expansion of the expressway system in the discussed countries. In addition, the socio-economic changes taking place in post-socialist countries overlapped with political conflicts that resulted, among others, in the break-up of federal Czechoslovakia and a war in Yugoslavia. The emerging new countries, such as the Czech Republic, Slovakia, Slovenia and Croatia, had to organize new structures administering roads and often completely reorient their own transport priorities and directions of development of national highway systems. The aforementioned political and economic changes caused stagnation in transport investments in the discussed countries and their fundamental limitation in the years 1990–2004. During this period, it was also expected that foreign private concessionaires would invest their own or borrowed funds in new highways. Tolls collected on the new roads constructed in this way were supposed to ensure profitability of the concession and a return on investment. Authorities wanted to build highways in the concession system, among others in Poland, Hungary and Croatia. After initial attempts to increase the pace of

expansion of the highway network through concessions, only Poland (licensed highways: Małopolska, Wielkopolska and Gdańsk) and Croatia (with various operators clustered in the organization "Huka" associating highway concessionaires) remained. Hungary, on the other hand, reverted to the traditional system of the state financing road construction. The Czech Republic and Slovakia, like Bulgaria and Romania, essentially maintained the state model of financing infrastructural investments during this period. This was also favored by the EU allocating significant pre-accession funds for the implementation of transport projects, especially in the field of road cross-border connections. This resulted in a significant revival of road construction in post-socialist countries aspiring to membership in the EU structures (tab. 1, fig. 2).

war and break-up of Yugoslavia caused additional disintegration of transport systems in these countries. The existing road networks of this type in Central European countries were then only at the stage of creating national connections. The most advanced construction of the national highway system took place in Poland, Hungary, the Czech Republic, Slovakia, Slovenia and Croatia. These countries, after integration with the European Union, focused on the modernization of transport infrastructure, treating the development of national and cross-border connections with neighboring countries as a priority[1].

According to the data from 2019, the highest indicators of the length of highways per 1000 km^2 in Central Europe were in Slovenia, Croatia, Hungary and the Czech Republic, and the lowest one in Romania.

Table 1. Density of the highway and expressway network in post-socialist EU countries in 2019

Country	Total area (in thou. km^2)	Population	Number of passenger cars in 2017 in thous.	Automotive, passenger cars per 1,000 inhabitants	Highways and expressways in km in 2019	Highways in km / 100 thous. population	Number of cars per 1 km of highways	Highways in km / 1000 km^2
Bulgaria BG	110 910	7 000 039	2771	393	812	11.4	3412	7.3
Croatia HR	56 594	4 105 493	1596	389	1351	32.0	1181	23.8
Czech Republic CZ	78 866	10 627 794	5538	522	1281	11.8	4323	16.2
Estonia EE	45 227	1 319 133	726	550	161	9.4	4509	3.5
Lithuania LT	65 300	2 791 093	1357	483	340	14.0	3991	5.2
Poland PL	312 696	38 433 600	22503	593	4249	11.1	5296	13.5
Romania RO	238 397	19 523 621	5998	307	850	4.2	7056	3.5
Slovakia SK	49 035	5 445 000	2223	408	767	8.7	2921	15.6
Slovenia SI	20 273	2 070 050	1118	541	783	37.3	1427	38.6
Hungary HU	93 030	9 771 000	3472	355	2090	15.5	1661	22.4
EU-28	**4 475 757**	**513 481 691**	**264 214**	**516**	**77680**	**15.1**	**3401**	**17.3**

Source: own compilation based on data from the EU Transport Committee and national road administrations and the Skyscraptercity website.

On the threshold of joining the European Union, Central European countries were characterized by unfavorable indicators of the number of vehicles and the length of highways per unit of area and the number of population. The development of national highway systems primarily aimed at developing transport links with the so-called "old" EU countries. The highway network of Central European countries at the time of accession to the EU structures did not create a coherent, supranational system of connections. The break-up of Czechoslovakia as well as the

The detailed values of the indicators are presented in Figure 2 and in Table 1. The indicator of the number of cars per 1 km of highways has a similar distribution: the most favorable one was in Croatia and Hungary, and the least favorable one in Romania. In 2017, the length of the European Union highway network was

[1] This was not the case in all countries. For example, Slovenia, due to a border dispute and a desire to take over some of the tourist traffic, delayed the construction of motorway connections towards Croatia.

77,396 km, of which 12,501 km (16%) were in Central European countries; in 2006, it was respectively: 63,400 km (EU) and 5,106 km (8%) in the analyzed countries. In 2019, the longest network of highways and expressways in Central Europe was in Poland (1) – 4,249 km, Hungary (2) – 2,090 km and Croatia (3) – 1,351 km. The full list of the length of the network of expressways in particular countries is presented in Table 2 and Figure 3. The presented data show that in the past 15 years individual post-socialist countries have multiplied the length of their national highway systems (tab. 2).

Republic and Lithuania (cf. Figure 4). The program of highway construction should be ahead of forecasts for the growth in the number of cars. So far, this has been the case only in the most developed EU countries, and some post-socialist countries such as Poland, Slovenia, the Czech Republic and Lithuania are just beginning to refer to them in the values of the above-mentioned indicators (fig. 3-4).

The greatest dynamics in the expansion of the highway network in the decade of 2011–2020 was demonstrated in Poland, Hungary, and to a lesser extent also in Romania and Bulgaria. In the first decade

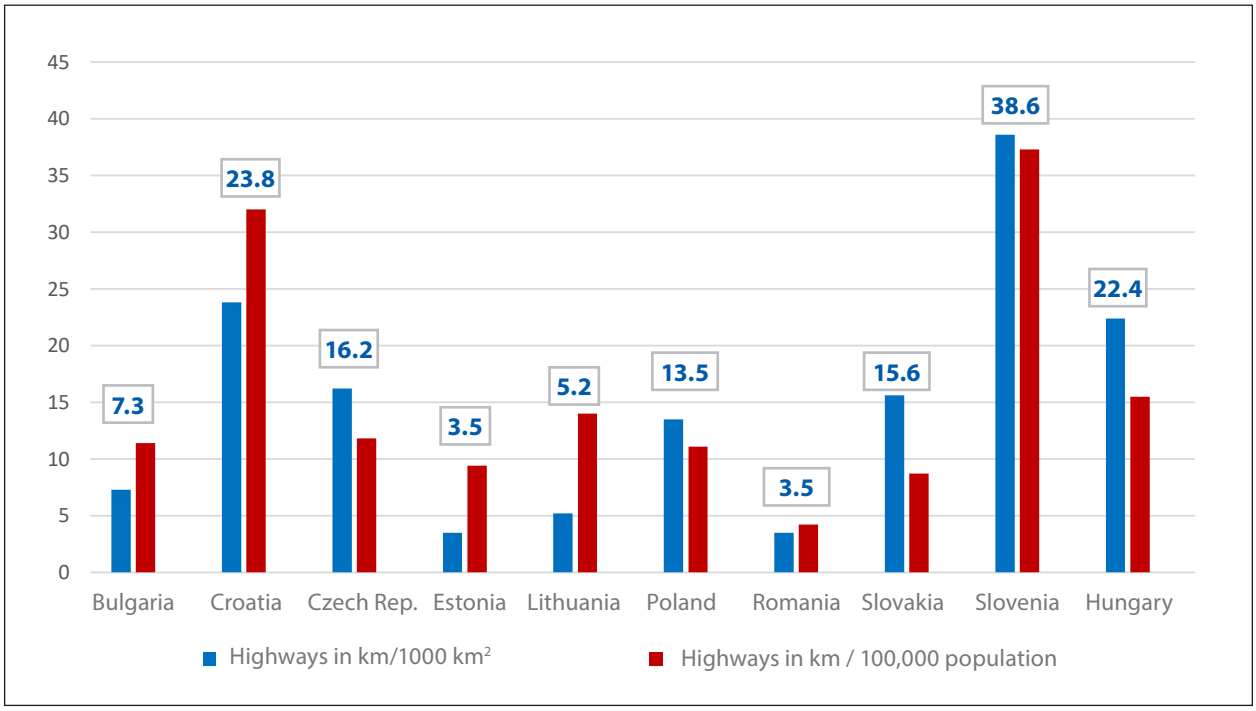

Fig. 2. Density of the highway and expressway network in post-socialist EU countries in 2019

Source: own elaboration based on data from Table 1.

The length of national highway networks in Central European countries is generally related to the number of motor vehicles in use. In 2007, a total of 31,443,000 passenger cars were registered in Central Europe, which accounted for 14% of the 229,764,000 passenger cars registered in 27 EU countries. In 2017, in the post-socialist countries there were already 47,302,000 passenger cars, which accounted for 18% of 264,214,000 cars registered in 28 EU countries. In 2017, the largest number of registered passenger cars was in Poland (1) – 22.5 million (14.6 million in 2007), Romania (2) – 5.9 million (3.5 million), the Czech Republic (3) – 5.5 million (4.2 million), in Hungary (4) – 3.4 million (3.0 million) and Bulgaria (5) – 2.7 million (2.0 million). Taking into account the number of passenger cars per 1,000 population, the highest motorization rates were recorded in Poland, Slovenia, the Czech

of the 21st century, Croatia and Slovenia, which at that time implemented the toll highway system, recorded significant increases in the length of the highway network. Toll roads were operated in 8 out of 11 discussed Central European countries; Lithuania, Latvia and Estonia do not have toll roads, the latter two due to the short length of roads of this type. Toll highways with the toll paid at tollbooths are used, among others, in Poland (3 concessionaires: Autostrada Małopolska [Lesser Poland Highway] (since 2000) on the 65 km section Kraków – Katowice, Autostrada Wielkopolska [Greater Poland Highway] (since 2003) on the 250 km section Konin – Września – Poznań – Nowy Tomyśl – Rzepin and Autostrada Gdańska [Gdansk Highway] (since 2008) on the 150 km section Gdańsk Rusocin – Nowe Marzy – Toruń). In 1995, tolls for using highways and dual carriageways in the

Table 2. Length of the highway network in post-socialist EU countries in 1990–2019

Countries	1990	1995	2000	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Bulgaria	273	277	319	331	331	394	418	418	418	437	458	541	605	610	734	762	796	796	812
Czech Rep.	357	414	501	546	564	633	657	691	729	734	745	751	776	776	776	1,223	1,240	1246	1281
Croatia	291	302	411	925	1,016	1,081	1,156	1,199	1,244	1,244	1,254	1,254	1,289	1,290	1,310	1,322	1,334	1,334	1,351
Estonia	41	65	93	96	99	99	96	104	100	115	115	124	140	141	147	145	154	157	161
Lithuania	421	394	417	417	417	309	309	309	309	309	309	309	309	309	309	314	324	340	340
Poland	257	246	425	781	848	1,013	1,083	1,282	1,454	1,560	1,865	2,495	2,805	3,100	3,131	3,252	3,510	3,811	4,249
Romania	113	113	113	228	228	228	281	281	321	332	350	550	644	683	747	747	763	806	850
Slovenia	228	293	427	483	569	579	579	696	747	771	768	769	770	770	773	773	783	783	783
Slovakia	192	198	296	316	328	328	365	384	391	416	419	419	420	420	463	463	482	752	767
Hungary	267	335	592	761	859	1,157	1,065	1,274	1,273	1,477	1,516	1,515	1,767	1,782	1,884	1,924	1,937	1,984	2,090
EU 28	42,176	48,269	55,111	61,236	63,107	64,718	66,275	67,814	69,966	71,122	71,804	73,031	74,318	74,840	75,820	76,817	77,396	.	.

Note: highways and expressways are counted together in Poland since 2000, in the Czech Republic since 2016, and in Slovakia since 2018. The data provided for Hungary since 2008 by the EU Transport Commission (Statistical Pocketbook, EU Transport in figures, 2019, pb2018-section 25) significantly differ from the data provided by, for example, the Hungarian-language version of Wikipedia, which quotes, for example, for 2008 – 1,113 km , 2010 – 1,290 km, 2015 – 1,447 km, 2016 – 1,481 km, 2017 – 1,503 km, 2018 – 1,524 km, 2019 – 1,600 km.

Source: own compilation based on data from the EU Transport Committee (http://ec.europa.eu/transport) and national road administrations and the Skyscraptercity website.

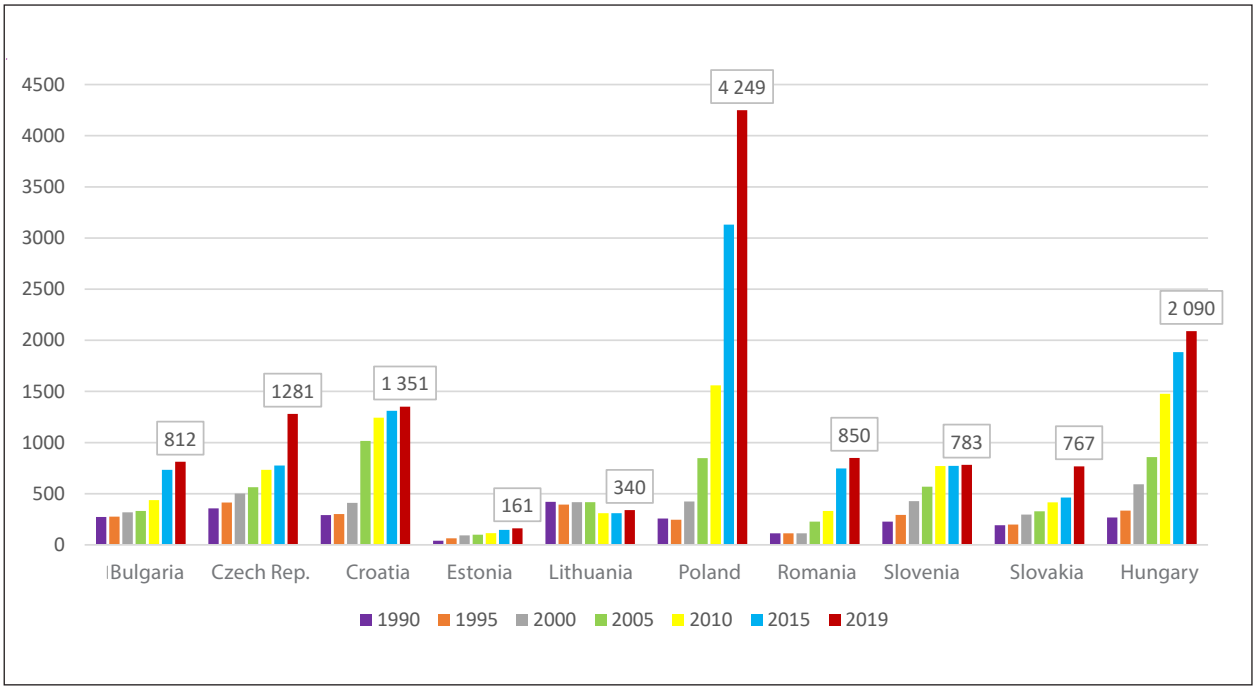

Fig. 3. Development of the network of highways and expressways in the EU post-socialist countries in 1990–2019.

Source: own elaboration based on data from Table 2.

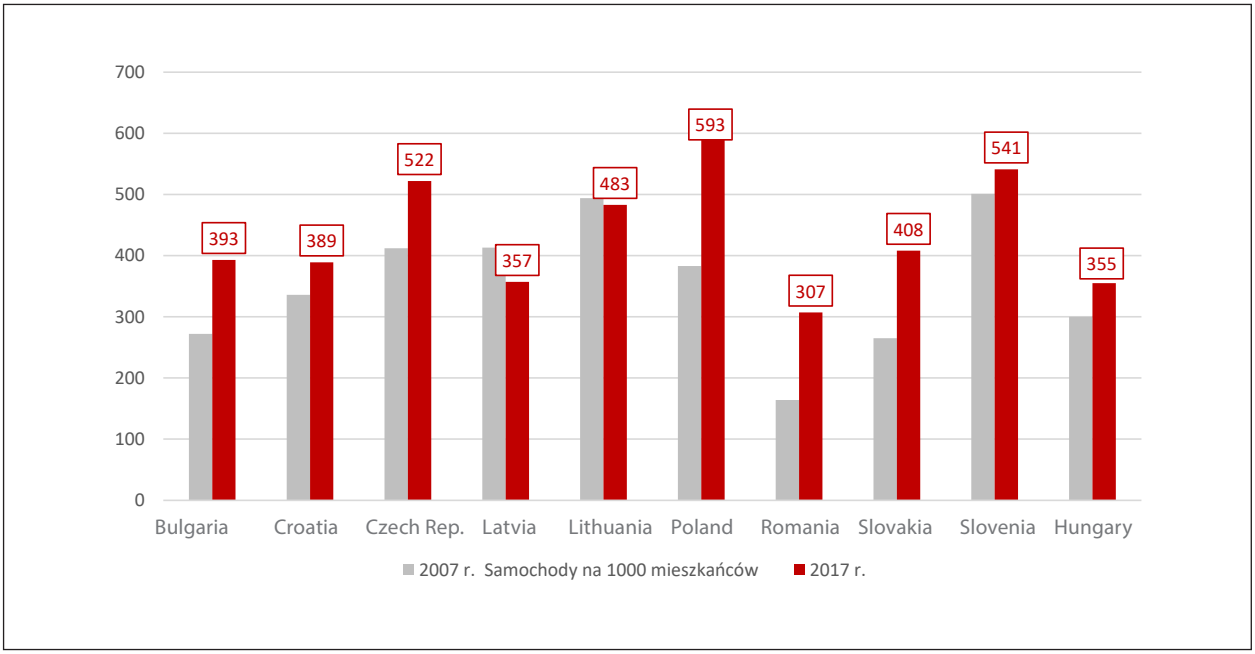

Figure 4. Motorization rates in post-socialist EU countries in 2007 and 2017

Source: own elaboration based on data from Table 1.

vignette system (paid-for stickers) were introduced by the Czech Republic and Slovakia, and later, after a temporary experiment with tollbooths, by Hungary and in 2008 by Slovenia. Vignettes are also valid on the roads of Romania and Bulgaria. Additionally, there are also toll bridges on the Danube river separating Romania and Bulgaria (Calafat – Vidin and Giurgiu – Ruse). In addition to Poland, the toll collection system at squares and in tollbooths is used by Croatia. Initially, Poland based its highway construction program partly on the concept of licensing the construction and operation, which is often associated with high

toll payments, e.g. on the 65-km section of A-4 Lesser Poland Highway or on the A-2 Poznań – Konin route on the Greater Poland Highway. Despite charging high tolls, the licensees did not make any significant line investments. For example, throughout almost the 20-year period of the concession on the Mysłowice Brzęczkowice – Kraków Balice section of the A-4 highway, the Lesser Poland Highway has failed to build an additional third lane, despite the fact that the area for it had already been reserved. It was only in 2019 that on the Greater Poland Highway the third lane was opened on the Poznań bypass on the 8-km A-2 Komorniki – Krzesiny section. Much lower tolls are collected by GDDKiA in the Via Toll system, for example on the A-4 section Wrocław – Gliwice Sośnica and on the A-2 section Konin – Stryków. In 2019, the highest tolls for vignettes were levied by the road administrations of Slovenia, Hungary and the Czech Republic. On the other hand, in the tollbooth system, the travel costs ranged from 4 euro cents for 1 km of highway in Croatia to 10 euro cents for 1 km in Poland (the Greater Poland Highway). The detailed costs of using highways by passenger cars in the vignette and tollbooth systems are presented in table 3.

The highway network in post-socialist Central European countries is at the stage of creating a coherent system of international connections. Most cross-border highway connections, mainly due to their central location in Central Europe and a well-developed highway network is in: Poland – 7 (including 4 with Germany and one with the Czech Republic, Slovakia and Ukraine each), Slovenia – 6 (two with Austria and Italy each and one with Hungary and Croatia each), Hungary – 6 (one highway connection with Austria,

Table 3. Tolls (in euro) for using highways in post-socialist EU countries in 2020.

Vignettes	**1 week or 10 days**	**1 month**	**1 year**
Bulgaria	15 BGN / 7.59	30 BGN / 15.17	97 BGN / 49.02
Czech Republic	310 K. č / 12.50	440 K. č / 17.50	1500 K. č / 60.00
Romania	7.00	13.00	28.00
Slovakia	10.00	14.00	50.00
Slovenia	15.00	30.00	110.00
Hungary	3500 Ft / 12.07	4,780 Ft / 16.48	42,980 Ft / 148.21
Tollbooth fees:	**Toll**	**Distance in km**	**Toll per 1 km**
A-1 Zagreb - Carapine	232 kn / 29.51	456	0.50 kn / 0.06
A-6 Zagreb – Rijeka (Delnice)	70 kn / 8.90	140	0.50 kn / 0.06
A-3 Zagreb – Lipovac	128 kn / 16.28	280	0.45 kn / 0.06
A-4 Zagreb (Chimney) – Gorican	44 kn / 5.60	115	0.38 kn / 0.05
A-2 Zagreb – Bregana	7 kn / 0.89	30	0.25 kn / 0.03
A-7 Rijeka – Rupa	8 kn / 1.02	28	0.28 kn / 0.04
A-1 Gdańsk (Rusocin) – Toruń	PLN 30.00 / 6.71	146	PLN 0.20 / 0.04
A-2 Rzepin – Poznań (Komorniki)	PLN 40.00 / 8.95	144	PLN 0.27 / 0.06
A-2 Poznań (Krzesiny) – Konin	PLN 44.00 / 9.85	95	0.46 PLN / 0.10
A-2 Konin – Łódź (Stryków)	PLN 9.90 / 2.19	108	PLN 0.10 / 0.02
A-4 Mysłowice – Krakow (Balice)	PLN 20.00 / 4.48	60	PLN 0.33 / 0.07
A-4 Wrocław – Gliwice (Sośnica)	PLN 16.20 / 3.63	160	PLN 0.10 / 0.02

Note: 1 euro = 26 CZK; 1 euro = 7.86 HRK (kuna); 1 euro = 290 Ft (forint); 1 euro = 1.94 BGN (lev); 1 euro = 4.46 PLN (zloty).

Source: own compilation based on www.tolls.eu; Croatia – www.hac.hr; Poland: A-1 Gdańsk Company, A-2 Autostrada Wielkopolska; A-4 Autostrada Małopolska; A-2 and A-4 GDDKiA.

Croatia, Serbia, Slovakia, Slovenia and Romania each), the Czech Republic – 4 (two with Germany and one with Slovakia and Poland each) and Slovakia – 4 (Austria, the Czech Republic, Poland and Hungary). Due to their peripheral geographic location, Balkan countries, Bulgaria (2) and Romania (1), have a small number of cross-border highway connections.

Consequently, although very slowly, the Central European countries which became members of the European Union on May 1, 2004, including Poland, Hungary, the Czech Republic, Slovakia and Slovenia, developed and implemented a program of building national highway systems, with particular emphasis on transit connections. Thus the Czech Republic built highways towards Germany (D-5 Prague – Plzeň – Nuremberg, D-8 Prague – Chomutov – Dresden) and Poland D-1 Brno – Ostrava – Rybnik) and ultimately D-11 Prague – Hradec Králové – Lubawka – Legnica. Poland implemented a program of building highways towards the border with Germany (A-4 Zgorzelec – Wrocław – Opole – Katowice – Kraków – Tarnów and A-2 Świecko – Poznań – Konin – Łódź – Warsaw), the Czech Republic (two sections A-1: Gdańsk – Toruń – Łódź and Częstochowa – Gliwice – Ostrawa) and Ukraine (A-4 Kraków – Rzeszów – Korczowa). The S-61 expressway Ostrów Mazowiecka – Łomża – Ełk – Suwałki – Budzisko connecting Poland with Lithuania is under construction. Hungary is completing the construction of highways towards Austria (apart from the existing M-1 Budapest – Győr – Vienna, M-85 Győr – Csorna – Sopron is also under construction), Slovakia (one lane on the M-15 Mosonmagyaróvár – Bratislava route was replaced by dual carriageway in 2018), Croatia (M-7 and later expanded M-6), Slovenia (M-7 branch) and Serbia (M-5) and is quickly completing the extension of the M-3 highway from Budapest eastwards (Polgár, Miskolc, Debrecen) to the borders with Slovakia, Ukraine and Romania. In the south – east of Hungary, M-43 highway leading to the Makó – Nădlac border crossing and further towards the Romanian A-1 highway was built. Further north, another connection to the Romanian border is under construction based on M-44 highway Kecskemét – Békéscaba. Slovenia modernized the already existing routes or built new ones towards Austria (in the area of Maribor and Villach), Italy (in the area of Trieste and Gorizia), Croatia and Hungary. Bulgaria, on the other hand, for many years was very slow in building A-4 Chirpan – Dimitrovgrad – Harmanli transit highway towards Turkey, which was finally completed in 2015. In 2015–2020, it has been intensively expanding A-3 "Struma" highway Sofia – Dupnitsa – Blagoevgrad – Sandanski – Kulata, which runs longitudinally along the Struma River valley towards the border with Greece. There is only one section left to complete (Blagoevgrad – Zheleznitz – Krupnik) located south of the city of Blagoevgrad. The practically held-up since the 1980s construction of highways in Romania gained momentum after accession to the EU. They started the construction of highways A-1 Nădlac – Arad – Timișoara – Lugoj – Deva – Sibiu and A-3 "Transylvania" Bucharest – Ploiești – Brașov – Târgu Mureș– Cluj Napoca – Oradea. The existing exit roads from Bucharest towards Pitești, Ploiești and Giurgiu were modernized, and new A-2 highway Bucharest – Cernavodă – Constanta, which leads to the port of Constanta on the Black Sea, was built.

The roads in European countries which emerged as a result of the collapse of the USSR, such as Lithuania, Latvia and Estonia, were in a poor technical condition. These countries inherited from the USSR a network of main roads built or modernized in the 1960s and 1970s for the strategic and transport needs of the Soviet empire, with a characteristic straight route of mostly single-carriageway main roads, isolated from the surroundings by a strip of trees and relatively numerous city ring roads. Due to the strategic character of roads leading from the USSR to the satellite countries of Eastern Europe, many roads, especially the latitudinal ones, were expanded into dual carriageways. The Olympic Games in Moscow, planned for 1980, were also an impulse to undertake these investments. For example, at that time Lithuania was given a dual carriageway on the Vilnius – Klaipeda route. When these Soviet republics gained independence, the technical condition of these roads was terrible, especially in terms of pavements, bridges and viaducts. Due to the difficult economic situation, these countries started to modernize their transit routes and formulate plans for their further development only after 2000. In 2007, Lithuania had a network of dual carriageways with a length of approx. 417 km. Since then, their length has not changed much, and, in the case of Lithuania, it even decreased to 392 km of highways in 2018, in Estonia – 154 km, and in Latvia there are not any at all. Interest in the construction of the Via Baltica highway surrounding the eastern shores of the Baltic Sea is shown by Lithuania, Latvia and Estonia, associated with the European Union, and Poland has already signed all contracts for the construction of its northeastern part based on the S-61 route Ostrów Mazowiecka – Łomża – Ełk – Suwałki.

Most highways in Central Europe are concentrated in the area of capital agglomerations, e.g. Budapest, Prague, Bratislava, Ljubljana, Zagreb, Sofia and Bucharest. So far, the Warsaw hub has one highway (A-2 Poznań – Łódź – Warsaw) and 4 expressways (S-7 Warsaw – Radom – Kielce, S-8 Piotrków Trybunalski – Warsaw – Białystok and S-17 Warsaw – Lublin), with the exit sections of these roads from Warsaw still being

under construction (S-7, S-17). When analyzing the distribution of the highway network, it can be concluded that their significant concentration is directly related to the population density of the agglomeration and the number of cars registered there. The largest number of motor vehicles is in the area of urban agglomerations, and the analysis of the structure of vehicle traffic on highways shows that passenger cars dominate. Among others, this forces introducing a ban on the movement of heavy goods vehicles on non-working days, when the trips are accompanied by significant congestion in car traffic. The spatial arrangement of the motorway network is related to the size and the nature of the agglomeration. In monocentric agglomerations, the highway system takes the shape of a radial system (see: the highway systems of the Budapest, Prague, Bratislava, Zagreb, Ljubljana, Bucharest and Sofia agglomerations in Figures 4–12). For example, Prague has the largest number of expressways in the discussed group of country capitals (8 highways and expressways), followed by Budapest (7), Zagreb (6), Ljubljana (4), Warsaw (4; a greater number of outbound routes of this type can be found in cities such as: Poznań – 7, Łódź – 5, Wrocław – 4 and Gliwice – 4). The remaining capitals, such as Bratislava, Sofia and Bucharest, have only three highways, which is partly due to their acentric location in the territory of their countries. Only in some national highway systems can we observe the beginnings of the formation of the "grate" (lattice) system, where there are usually a few parallel routes running both latitudinally and longitudinally, with a small number of "diagonal" connections. Poland exemplifies this type of spatial distribution of the network of expressways. Individual agglomerations here are connected by roads running latitudinally (A-2 Poznań – Łódź – Warsaw, A-4 Legnica – Wrocław – Katowice – Kraków – Rzeszów, S-6 Szczecin – Goleniów – Kołobrzeg – Koszalin and ultimately Gdańsk), or longitudinally (A-1 Gdańsk – Toruń – Łódź – Gliwice – Rybnik, S-3 Szczecin – Gorzów Wlkp. – Zielona Góra – Legnica – Wałbrzych, S–5 Wrocław – Poznań – Bydgoszcz and S -7 Gdańsk – Warsaw – Radom – Kielce – Kraków), and the only "diagonal" connections so far are the roads S-8 Wrocław – Łódź – Warsaw – Białystok and still being constructed S-17 Warsaw – Lublin. The layout of the highway network is often determined by the orography of the terrain, especially the course of mountain ranges (cf. the highways taking advantage of intra-mountainous depressions in Croatia, Slovenia and Slovakia), large rivers (the highway in the Váh valley in Slovakia, or in the Danube valley in Hungary) and sea coasts (A-1 along the Adriatic coast in Croatia). Due to the diversified hypsometry of mountain areas, the costs and the time of construction of engineering structures, such as tunnels, overpasses and bridges, are increasing. Countries such as Slovenia, Croatia, and Slovakia were forced to build them, just like also recently Poland (tunnels started or planned in the mountain sections of S-1, S-3, S-7 and S-19). In the analyzed countries, there are different highway systems, from the aforementioned "grate" one in Poland, where major urban agglomerations (Warsaw, Upper Silesian conurbation, Kraków, Łódź, Poznań, Wrocław) will create regional hub systems in the future, to the already existing classic radial systems based on capital agglomerations dominating in the settlement system (Budapest, Prague, Bratislava, Bucharest, Sofia, Zagreb, Ljubljana). Certain deviations from these spatial regularities can be found, among others, in the Czech Republic, where apart from Prague, which is dominant in the system, there are hub centers located in Brno and Ostrava. A clearly acentric network system can be found in the highway system of Slovakia (Bratislava located close to the border), similarly in Romania (with Bucharest located behind the Carpathian arc) and Bulgaria (the Sofia hub located a short distance from the border with Serbia).

Conclusions

Analysis of statistical data (cf. fig. 1) concerning the network of express roads in the 11 discussed post-socialist countries enabled selecting three groups of countries that differ in terms of the pace and length of growth of these roads. Therefore, the following groups of countries can be distinguished: the first group with a stagnant length of the network (Lithuania, Latvia and Estonia), the second group with a recently stable, but slight increase in the length of the network (Bulgaria, Croatia, the Czech Republic, Romania, Slovakia and Slovenia), and the third group of countries dynamically developing this type of roads (Poland and Hungary). This breakdown is not unambiguous and definite, because the analyzed countries in the past also had periods of intense growth, or stagnation or regression in transport investments. Undoubtedly, however, an unambiguous conclusion should be made: joining the EU and funds for the development of transport infrastructure had a decisive influence on the revival of the pace of investments in the field of expressways in the discussed countries. Poland is the unquestionable leader in this ranking, as in the past 15 years since its accession to the EU, it has experienced a certain "boom" in road construction, comparable to the best years of building such routes, e.g. in Germany, Spain or France. This is evidenced, among others, by record breaking newly opened highways and expressways, for example, in 2012 – 650 km and in 2019 – 412 km.

The Central European highway network is at the stage of creating a coherent system of international connections. Currently, Poland (7), Slovenia (6), Hungary (6), the Czech Republic (4) and Slovakia (4) have the largest number of cross-border highway connections, mainly due to their central location in Central Europe and a well-developed highway network. So far, the Balkan countries Bulgaria (2) and Romania (1) have single cross-border highway connections – due to their peripheral geographical location.

Unfortunately, errors were not avoided in the process of shaping the highway connections. I consider the adoption of a toll collection system at tollbooths (e.g. in Poland and Croatia), which often causes congestion and slows down traffic, to be such a mistake. Additionally, it also increases construction costs and land occupancy. Some countries that previously used the tollbooth system decided to withdraw from it and adopt a vignette system that is more convenient for users (e.g. Hungary and Slovenia). On the other hand, it is beneficial for highways to implement remote (satellite, radio or video recording) systems of toll collection for trucks.

Another disadvantage in the highway system is their defragmentation and a lack of continuity of routes as well as different technical parameters (e.g. limited number of lanes, collision sections, etc.), which also affects the traffic capacity and flow. A consistent expansion and proper sequence of investment implementation in accordance with the previously adopted long-term plan is particularly important in shaping the highway network.

Unfortunately, the implementation of national programs for the construction of a network of highways and expressways also encountered objective difficulties caused by the unreliability of construction companies participating in tenders. Such cases occurred, for example, in Poland in 2012 (Chinese companies) and in 2019 (Italian companies). Similar situations also occurred during road investments carried out in Slovakia and Romania, and earlier in Bulgaria. The aforementioned incidents significantly lengthen and increase the cost of road construction works.

References

Bezruchonak A., 2017, Geographic structure of road transportation and logistics infrastructure in the Republic of Belarus, *Prace Komisji Geografii Komunikacji PTG*, 20 (2), s. 8-18

Cialone E., Saccone A., 1999, Le autostrade in Europa, *Autostrade*, nr 1, s. 81-116.

EU Transport in Figures: *Statistical Pocketbook 2018*, 2018, Publications Office of the European Union, Luxembourg.

Fielenbach R., Firk H., 1992, Bundesautobahn in den 80er Jahren, *Strasse+Autobahn*, H.5.

Kent B., 2019, Taking the high-tech road, *Highways*, nr 1, p. 22-24.

Komornicki T., 1995, Transgraniczna infrastruktura transportowa Polski, *Przegląd Geograficzny*, t. LXVII, z. 1-2, s. 45-53.

Komornicki T., 2003, Factors of development of car ownership in Poland, *Transport Reviews*, 23, 4, Taylor and Francis, London, p. 413-432.

Komornicki T., Rosik P., Śleszyński P., Solon J., Wiśniewski R., Stępniak M., Czapiewski K., Goliszek S., 2013, *Wpływ budowy autostrad i dróg ekspresowych na rozwój społeczno-gospodarczy i terytorialny Polski.* Ministerstwo Rozwoju Regionalnego, Warszawa, s. 215.

Komornicki T., Śleszyński P., Rosik P., Pomianowski W., 2010, Dostępność przestrzenna jako przesłanka kształtowania polskiej polityki transportowej, *Biuletyn KPZK*, nr 241, Komitet Przestrzennego Zagospodarowania Kraju PAN, Warszawa, s. 167.

Komornicki T., Wiśniewski R., Baranowski J., Błażejczyk K., Degórski M., Goliszek S., Rosik P., Solon J., Stępniak M., Zawiska I., 2015, Wpływ wybranych korytarzy drogowych na środowisko przyrodnicze i rozwój społeczno-ekonomiczny obszarów przyległych, *Prace Geograficzne*, nr 249, Instytut Geografii i Przestrzennego Zagospodarowania PAN, Warszawa, s. 202.

Komornicki T., 2019, Transport infrastructure and accessibility. [w]: *Social and economic development in Central and Eastern Europe: Stability and change after* 1990, red. Grzegorz Gorzelak, Routledge, London, p. 244-266.

Koziarski S., 2004, *Rozwój przestrzenny sieci autostrad na świecie*, Uniwersytet Opolski, Studia i monografie, nr 341, Opole, s. 312.

Koziarski S., 2014, *Polska w systemie transportowym Unii Europejskiej. Inwestycje infrastrukturalne*, Uniwersytet Opolski, Studia i monografie, nr 512, Opole, s. 235

Koziarski S., 2018, Kierunki rozwoju sieci autostrad i dróg ekspresowych w Polsce, *Prace Komisji Geografii Komunikacji Polskiego Towarzystwa Geograficznego*, t. 21 (3), s. 7-30.

Palmowski T., 2013, *Kaliningrad – szansa czy zagrożenie dla Europy Bałtyckiej? Monografia społeczno-gospodarcza*, Uniwersytet Gdański, Wydawnictwo „Bernardinum", Gdańsk – Pelplin, s. 352.

Połom M., Goliszek S., 2017, Transport in Poland during the period of accession to the European Union, *Journal of Geography*, Politics and Society, 7, 3, s. 41–49.

Rodrigue J.-P., Comtois C., Slack B., 2006, *The Geography of Transport Systems*, Routledge, London.

Rosik P., 2012, Dostępność lądowa przestrzeni Polski w wymiarze europejskim, *Prace Geograficzne*, nr 233, Instytut Geografii i Przestrzennego Zagospodarowania PAN, Warszawa, s. 307.

Rosik P., Komornicki T., Goliszek S., Śleszyński P., Szarata A., Szejgiec-Kolenda B., Pomianowski W., Kowalczyk K., 2018, Kompleksowe modelowanie osobowego ruchu drogowego w Polsce. Uwarunkowania na poziomie gminnym. *Prace Geograficzne*, nr 267, Instytut Geografii i Przestrzennego Zagospodarowania PAN, Warszawa, s. 242.

Rosik P., Kowalczyk K., 2015, Rozwój infrastruktury drogowej i kolejowej a przesunięcie modalne w Polsce w latach 2000-2010, *Prace Geograficzne*, nr 248, Instytut Geografii i Przestrzennego Zagospodarowania PAN, Warszawa, s. 215.

Runge J., 2007, *Metody badań w geografii społeczno-ekonomicznej – elementy metodologii, wybrane narzędzia badawcze*, Wydawnictwo Uniwersytetu Śląskiego, Katowice, s. 471.

Śleszyński P., 2009, Rozwój nowoczesnej drogowej sieci transportowej a efektywność połączeń głównych ośrodków miejskich (1989-2015), *Autostrady*, nr 7, s. 50-53.

Śleszyński P., 2014, Transport- and settlement-related time efficiency of road journeys taken in Poland, *Geographia Polonica*, Volume 87, Issue 1, pp. 157-160.

Taaffe E.J., Gauthier H.L., O'Kelly M.E., 1996, *Geography of transportation*, Prentice Hall, New Jersey.

Taylor Z., Ciechański A., 2017, Deregulacja i przekształcenia własnościowe przedsiębiorstw transportu lądowego w Polsce na tle polityki spójności UE, *Prace Geograficzne*, nr 257, Instytut Geografii i Przestrzennego Zagospodarowania PAN, Warszawa, s. 269.

Taylor Z., Ciechański A., 2018, Systemic transformation and changes in surface transport companies in Poland: A synthesis after twenty-five years, *Journal of Transport Geography*, 70, s. 114-122.

Taylor Z., Potrykowski M., 1982, *Geografia transportu. Zarys problemów, modeli i metod badawczych*, PWN, Warszawa.

Wendt J., 1999, Geopolityczne aspekty tranzytu w Europie Środkowej, *Geopolitical Studies*, vol. 6, Instytut Geografii i Przestrzennego Zagospodarowania PAN, Warszawa.

Węcławowicz G., Bański J., Degórski M., Komornicki T., Korcelli P., Śleszyński P., 2006, *Przestrzenne zagospodarowanie Polski na początku XXI wieku*, Monografie, nr 6, Instytut Geografii i Przestrzennego Zagospodarowania PAN, Warszawa.

Wiskulski T., 2017, Drogowa dostępność transportowa z Polski do regionów turystycznych w Chorwacji, *Prace Komisji Geografii Komunikacji PTG*, t. 20(4), s. 62-73.

Internet sources

https://www.gddkia.gov.pl [10.02.2020]
https://www.avtomagistrali.com/bg/ [10.02.2020]
https://www.ceskedalnice.sk [10.02.2020]
https://www.cnadnr.ro [10.02.2020]
https://www.dars.si [10.02.2020]
https: //www.dialnice.smz.sk [10.02.2020]
https://www.hac.hr [10.02.2020]
https://www.historiadialnic.sk [10.02.2020]
https://www.huka.hr [10.02.2020]
https://www.ndsas.sk [10.02.2020]
https://www.rsd.cz [10.02.2020]
https://www.skyscrapercity.com [10.02.2020]
https://www.ssc.sk [10.02.2020]
https://www.ec.europa.eu/transport [10.02.2020]
https://www.130km.ro [10.02.2020]

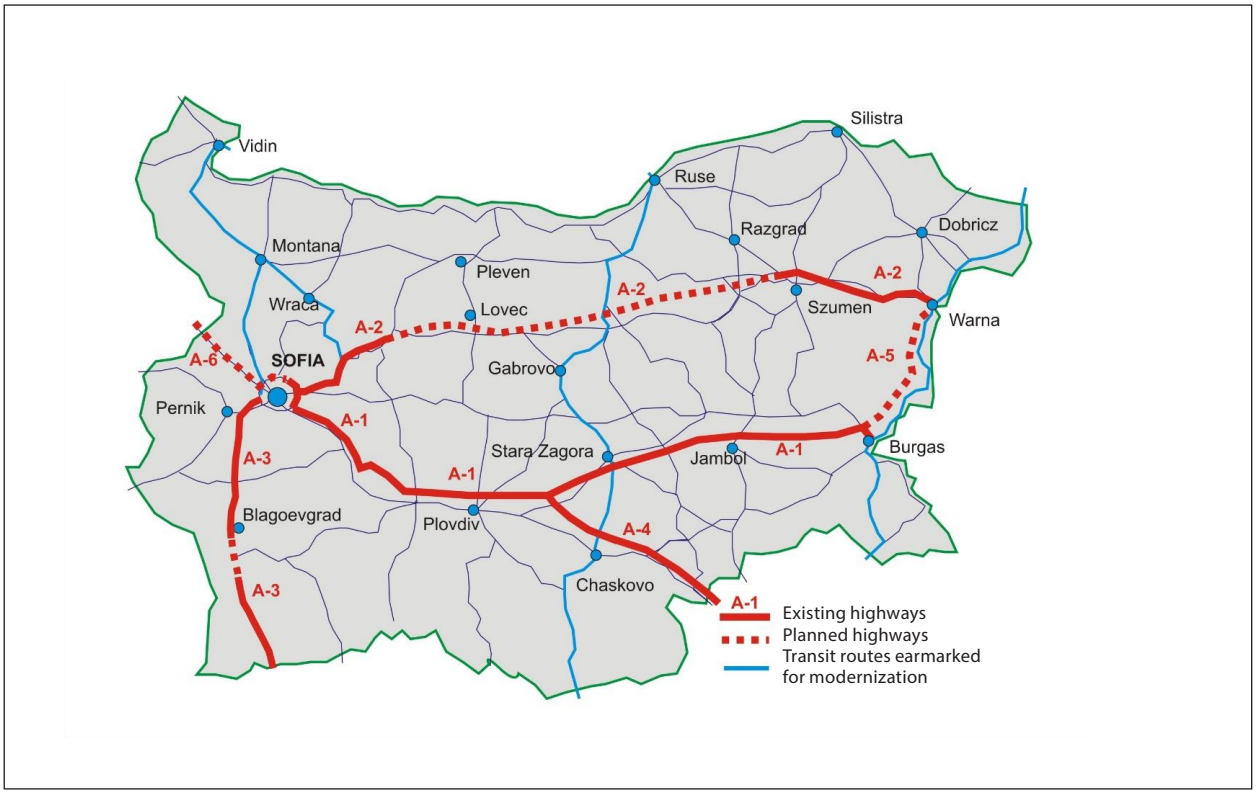

Fig. 5. Highways in Bulgaria (2019).

Source: Own elaboration.

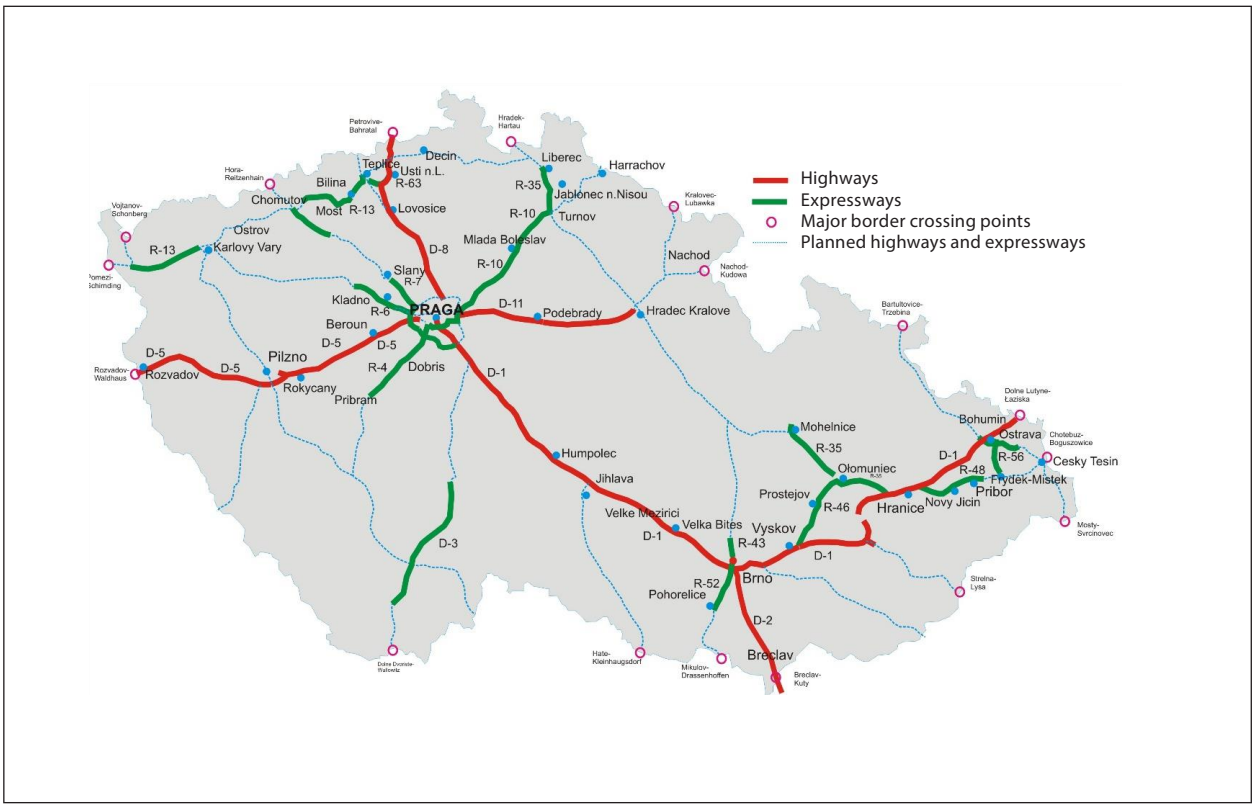

Fig. 6. Highways and expressways in the Czech Republic (2019).

Source: Own elaboration.

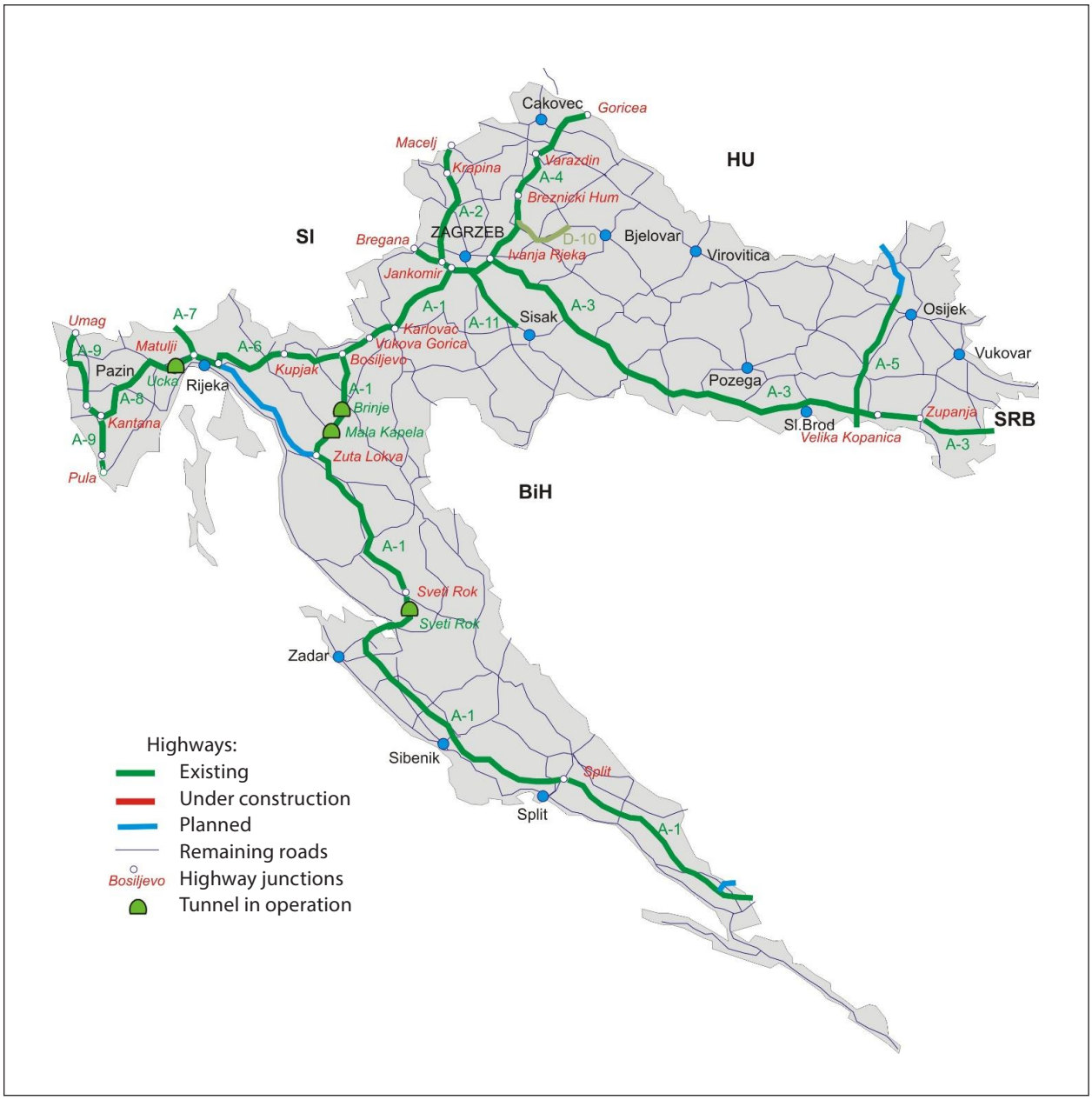

Fig. 7. Highways in Croatia (2019).

Source: A map updated by the author, taken from the website: www.huka.hr.

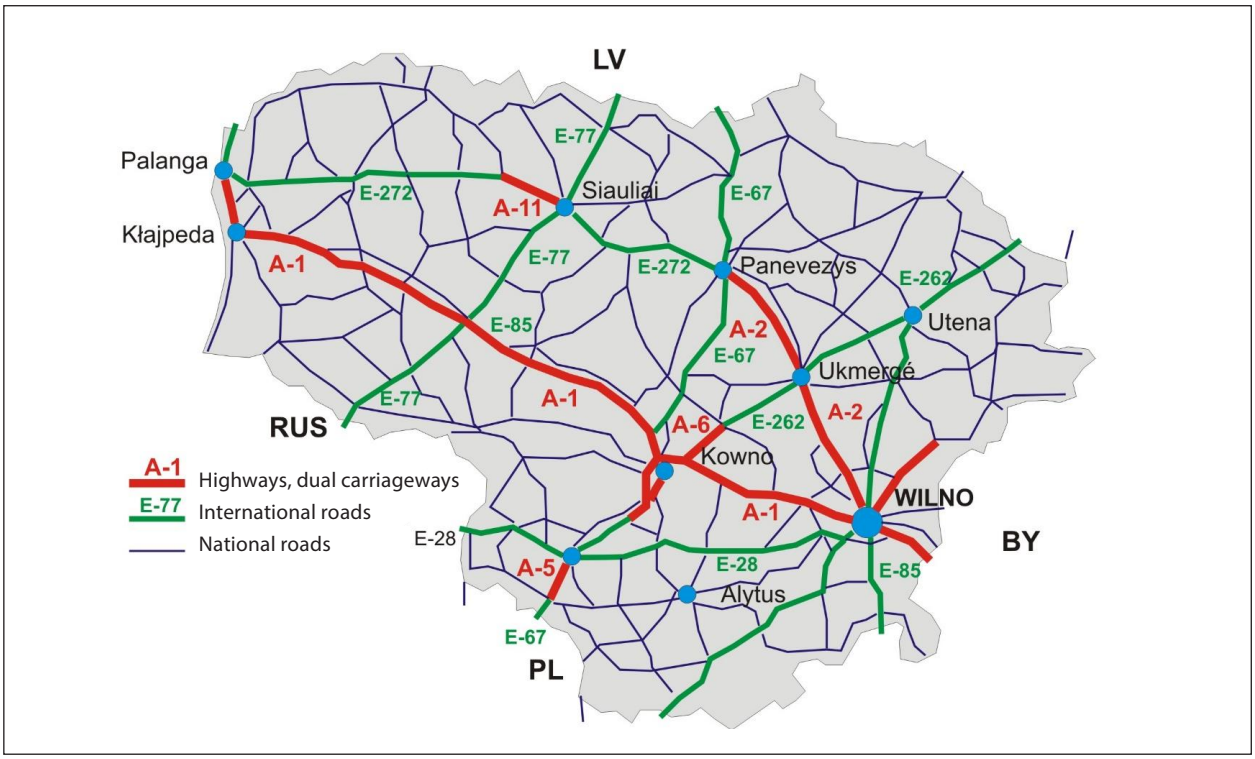

Fig. 8. Roads in Lithuania (2019).

Source: Own elaboration.

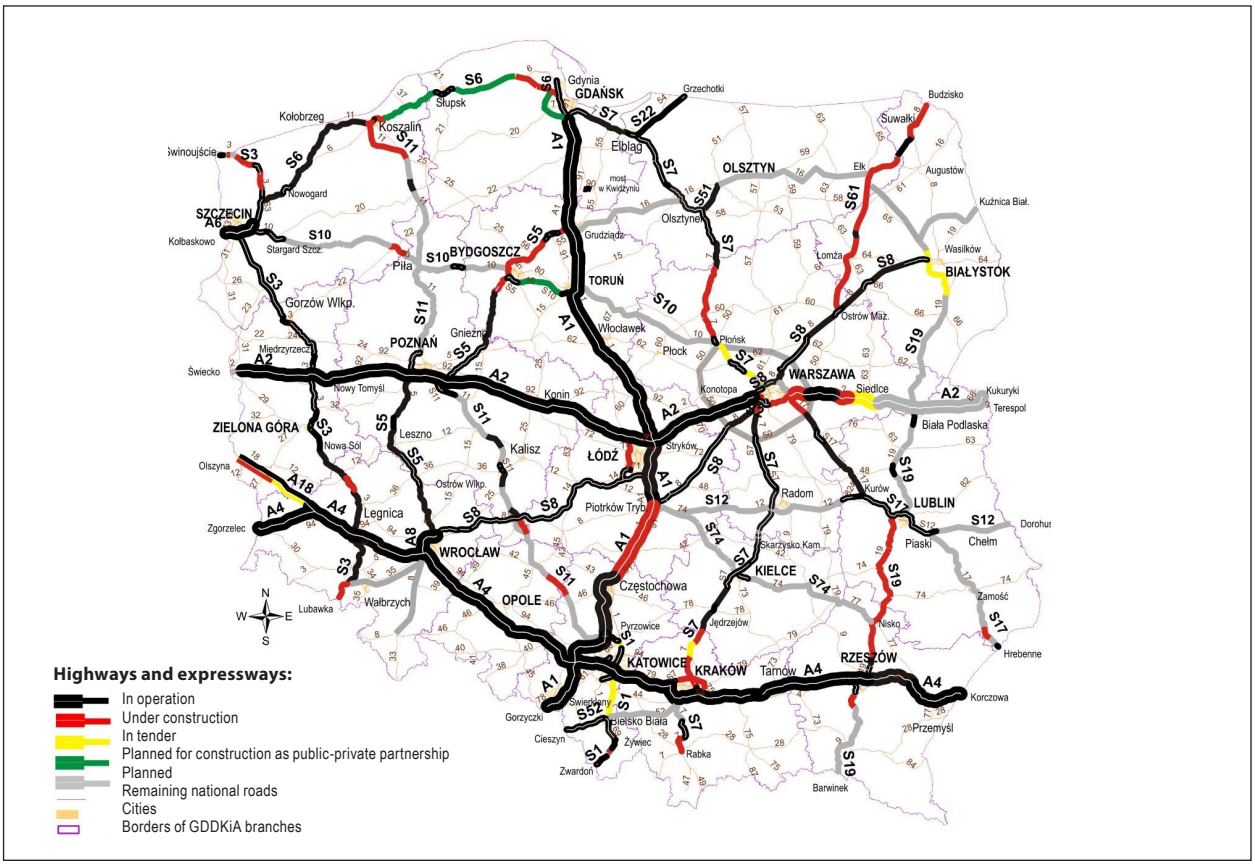

Fig. 9. Highways, expressways and national roads in Poland (2019).

Source: Map updated by the author, taken from the website www.gddkia.gov.pl.

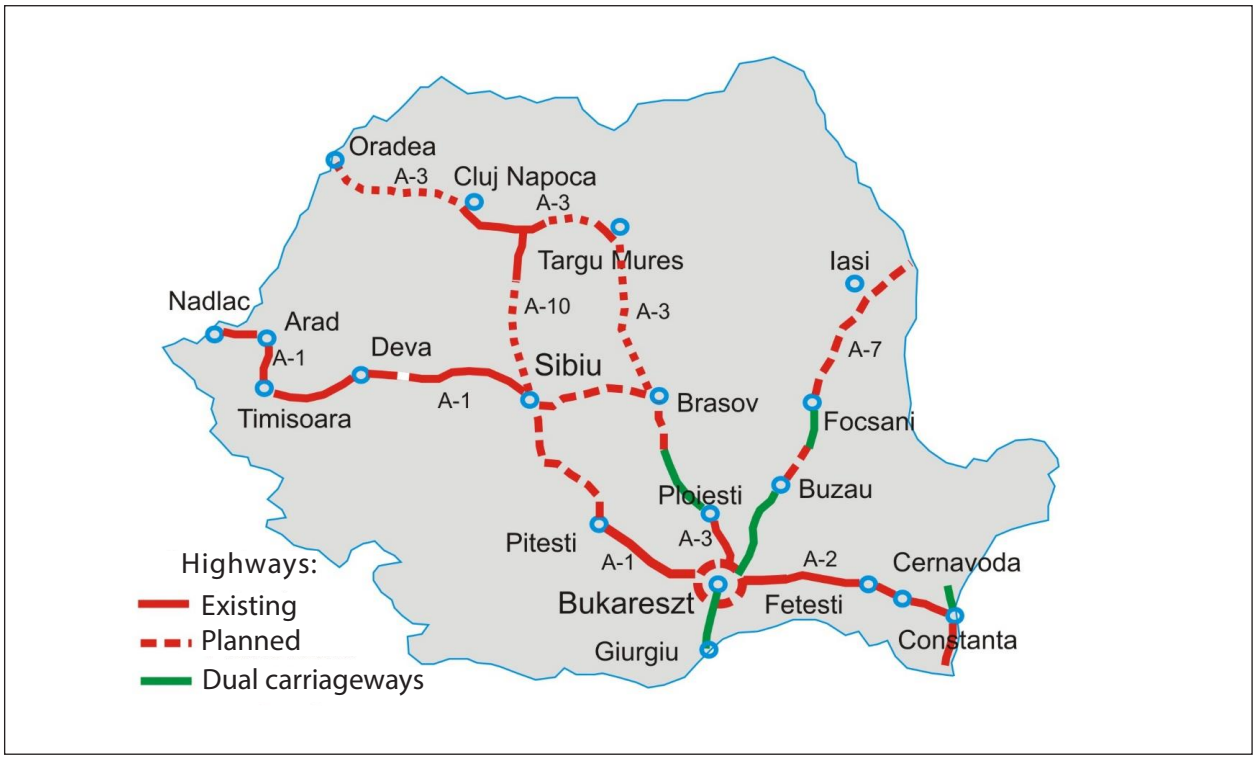

Fig. 10. Highways in Romania (2019).

Source: Own elaboration.

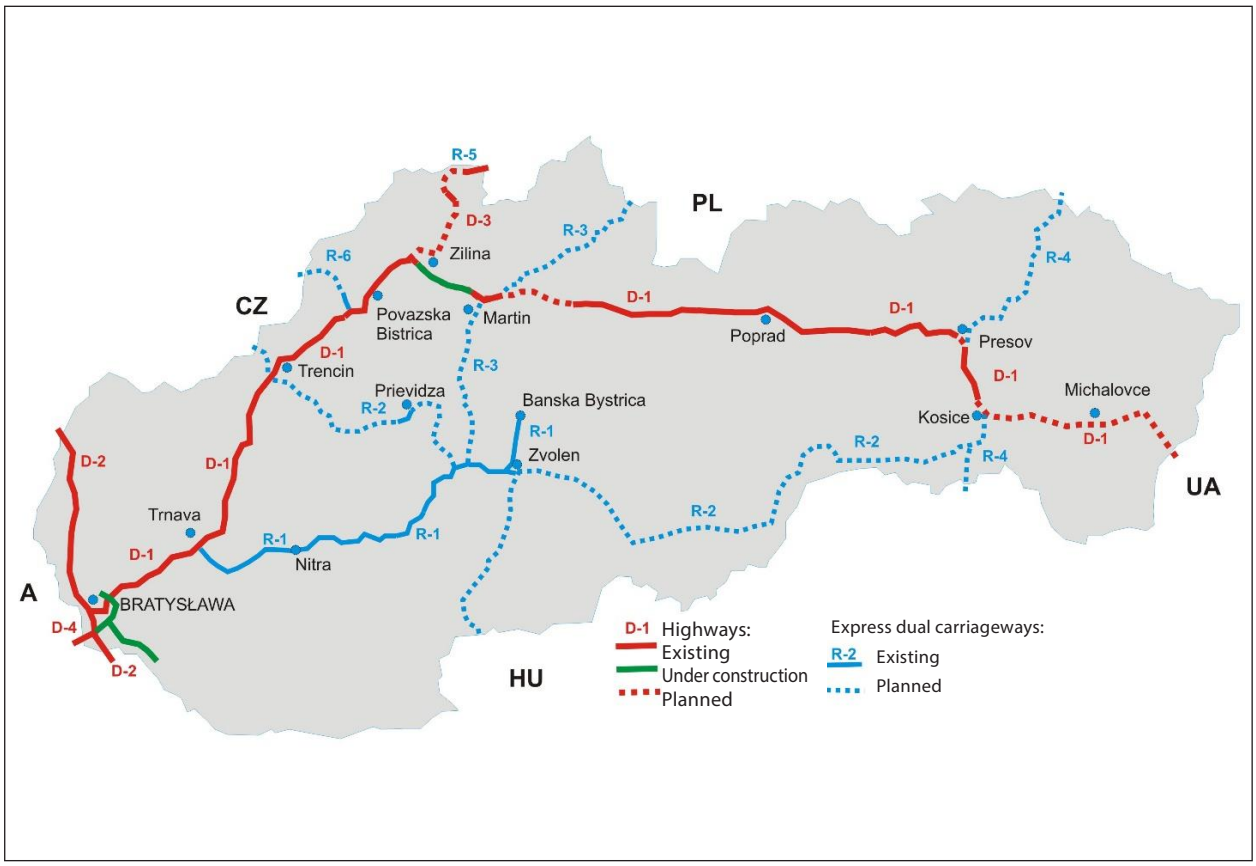

Figure 11. Highways and expressways in Slovakia (2019)

Source: own elaboration

Figure 12. Highways in Slovenia (2019)

Source: a map updated by the Author taken from the website: www.dars.si

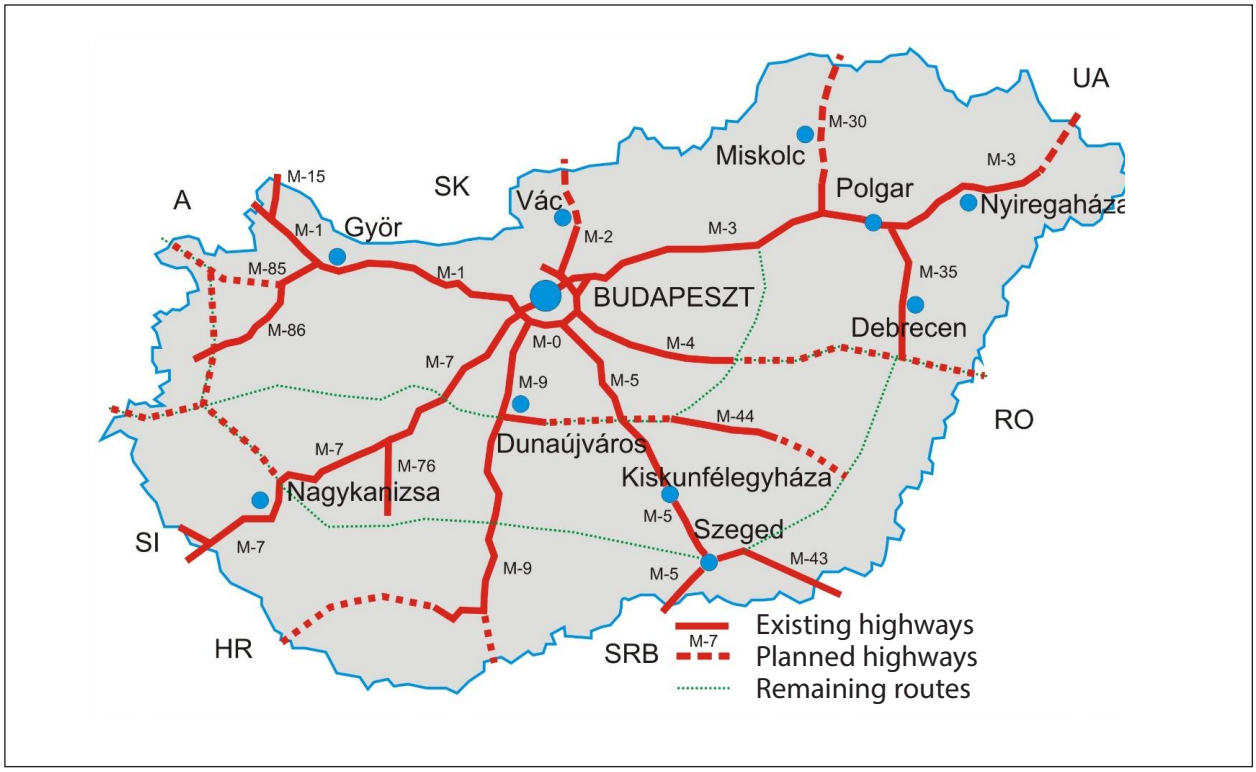

Fig. 13. Highways in Hungary (2019).

Source: Own elaboration.

Tab. 4. State of implementation of major highways and expressways in post-socialist EU countries in 2019

Highways / Country	planned in km	in operation in km	under construction in km	% of completion
A-1 "Trakia" Sofia - Pazardzhik - Plovdiv - Stara Zagora - Sliven - Yambol - Burgas	360	360	0	100
A-2 "Hemus" Sofia - Botevgrad - Pleven - Veliko Tyrnovo - Shumen - Varna	418	175	11	42
A-3 "Struma" Sofia - Pernik - Dupnitsa - Blagoevgrad - Sandanski - Kulata	172	136	11	79
A-4 "Maritsa" Chirpan - Dimitrovgrad - Captain Andreevo	117	117	0	100
Total – Bulgaria	**1365**	**807**	**68**	**59**
A-1 Zagreb (Lučko) - Bosiljevo - Split - Ploče - Dubrovnik	554	483	0	87
A-3 Bregana - Zagreb - Slavonski Brod - Lipovac	307	307	0	100
A-4 Zagreb (Ivanja Reka) - Varaždin - Goričan	97	97	0	100
A-6 Bosiljevo - Rijeka (Orehovica)	81	81	0	100
A-7 Rupa - Rijeka - Žuta Lokva	99	34	0	34
Total – Croatia	**1745**	**1325**	53	**75**
D-1 Prague - Jihlava - Brno - Vyškov - Hulín - Přerov - Lipník - Bělotín - Ostrava - Bohumín	376	366	0	97
D-3 Prague - Tábor - České Budějovice - Dolní Dvořiště	172	70	20	41
D-5 Prague - Beroun - Rokycany - Plzeň - Rozvadov	151	151	0	100
D-6 Prague - Karlovy Vary - Sokolov - Cheb - Pomezí nad Ohří	167	94	15	56
D-8 Prague - Lovosice - Ústí nad Labem - Krásný Les	94	94	0	100
D-11 Prague - Poděbrady - Hradec Králové - Jaroměř - Trutnov - Královec	154	92	0	60
Total – the Czech Republic	**2135**	**1254**	**59**	**59**
A-1 Gdańsk Rusocin - Toruń - Łódź Stryków - Częstochowa - Gliwice - Gorzyczki	658	487	81	86
A-2 Świecko - Nowy Tomyśl - Poznań - Łódź Stryków - Warsaw - Siedlce - Kukuryki	622	475	38	76
A-4 Jędrzychowice - Legnica - Wrocław Katowice - Kraków - Rzeszów - Korczowa	673	673	0	100
S-3 Świnoujście - Szczecin - Gorzów Wlkp. - Zielona Góra - Legnica - Lubawka	471	345	91	73
S-7 Gdańsk - Elbląg - Mława - Warsaw - Radom - Kielce - Kraków - Rabka	706	457	179	65
S-8 Kłodzko - Wrocław - Sieradz - Łódź - Warsaw - Wyszków - Zambrów - Białystok - Choroszcz	615	541	0	88
Total – Poland	**8200**	**4335**	**1124**	**53**
A-1 Bucharest - Pitești - Sibiu - Deva - Lugoj - Timișoara - Arad - Nădlac	580	445	13	78
A-2 Bucharest - Fetești - Cernavodă - Constanta	203	203	0	100
A-3 Bucharest - Ploiești - Brașov– Sighișoara - Târgu Mureș - Cluj-Napoca - Zalău - Oradea Borș	606	138	45	18
Total – Romania	**2100**	**850**	**146**	**40**
A-1 Šentilj - Maribor - Celje - Ljubljana - Postojna - Koper	245	245	0	100
A-2 Karavanke - Kranj - Ljubljana (Kozarje - Malence, A-1) - Novo Mesto - Obrežje	175	175	0	100
A-5 Maribor - Murska Sobota - Pince	80	80	0	100
Total – Slovenia	**.**	**623**	**0**	**.**
D-1 Bratislava - Trnava - Trenčín - Žilina - Prešov - Košice -Záhor	510	379	48	74
D-2 Brodské - Malacky - Bratislava - Čunovo	80	80	0	100
D-3 Hričovské Podhradie - Žilina - Čadca - Skalité	66	34	6	52
R-1 Trnava - Nitra Zvolen - Banská Bystrica- Ružomberok	271	179	0	66
R-2 Trenčín- Prievidza - Zvolen - Lučenec - Košice	337	60	13	18
R-3 Trstená - Martin - Žiar nad Hronom - Šahy	185	17	4	9
Total – Slovakia	**1904**	**781**	**130**	**41**
M-1 Budapest - Tatabanya - Győr - Mosonmagyarovar - Hegyeshalom	171	171	0	100
M-3 Budapest - Hatvan - Füzesabony - Polgár - Nyíregyháza - Beregdaróc	307	280	0	91
M-4 Budapest - Szolnok - Puspokladany - Berettyoujfalu - Nagykereki	233	66	49	29
M-5 Budapest - Kecskemét - Szeged - Röszke	173	173	0	100
M-6 Budapest - Dunaújváros - Szekszárd - Ivándárda	212	193	0	91
M-7 Budapest - Székesfehérvár - Siófok - Nagykanizsa - Letenye	233	233	0	100
Total – Hungary	**3222**	**1630**	**243**	**50**

Source: Compiled based on the highway lists on the national Wikipedia pages: Bulgaria, Croatia, the Czech Republic, Poland, Romania, Slovenia, Slovakia and Hungary.

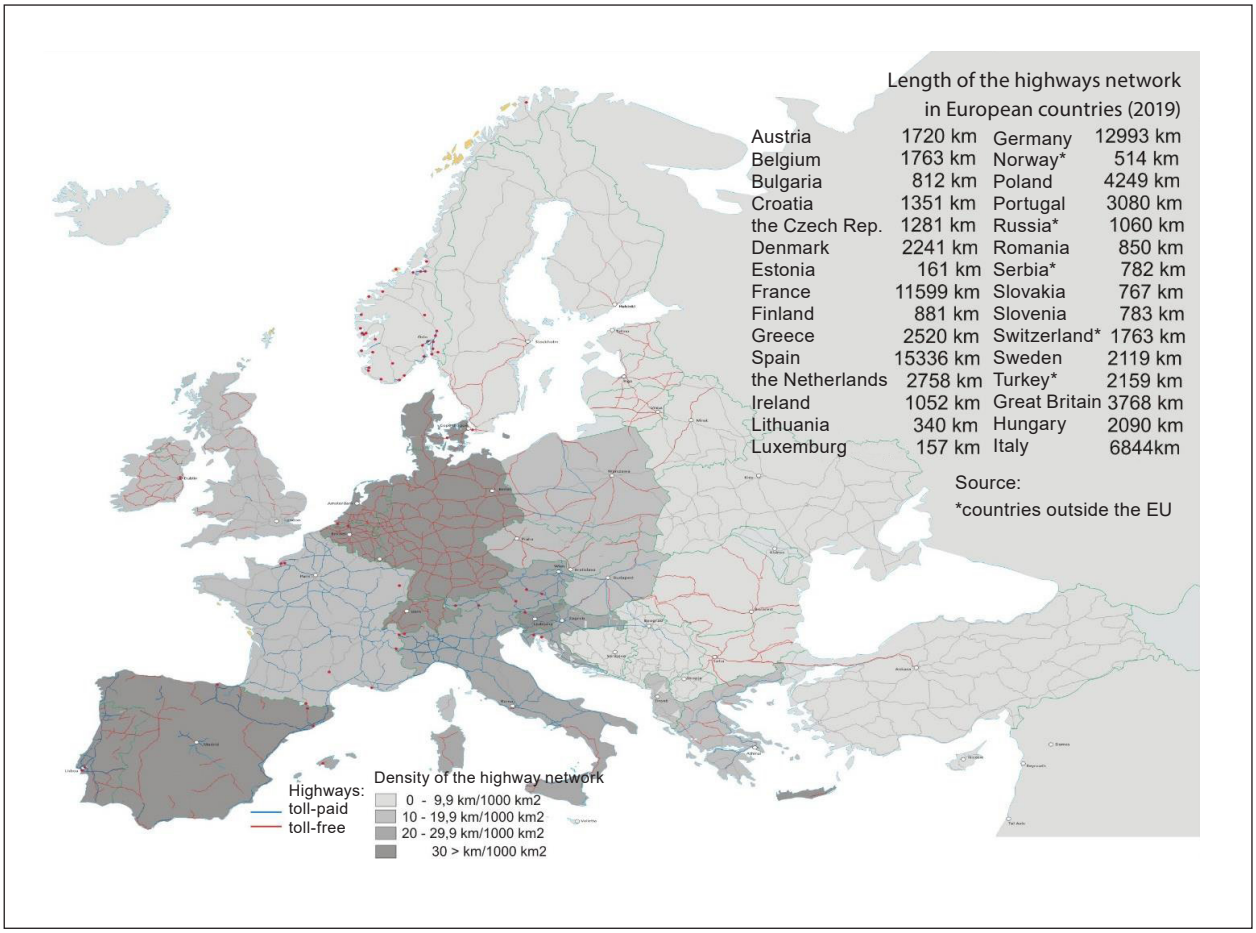

Fig. 14. Highways and expressways in Europe (2019).

Source: Map updated by the Author taken from the Asecap website. Figures compiled based on Eurostat and national road administration agencies.