NEEDS AND POSSIBILITIES OF DEVELOPMENT OF THE MACEDONIAN MOTORWAYS

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Abstract. The road network has been compared to the human blood circulation since the beginning of its development, the analogy referring to both its function and its hierarchically arranged and branching structure. In other words, the balanced development and the coordinated function, starting from the main arteries (motorways) until to the capillary system (local roads) is a precondition to the overall rationality of the existence and development of the organism (the country) and its vital functions (e.-g economy).

Key words: Roads, development, road network, maintenance, annual average daily traffic

1. Foreword

Any deviation from the optimal balance on any side entails similar problems which regularly raise the question: How to distribute the available funds for maintenance and construction of the different levels of road network in order to achieve the maximal approach to the balance of the overall function? The essential criterion for the distribution is the justifiability of the investments, that is, the expected level of profit acquired as related to the expenses and this according to the analysis of the justifiability on the level of certain routes and/or sections, from the viewpoint of the road network as a subsystem of traffic.

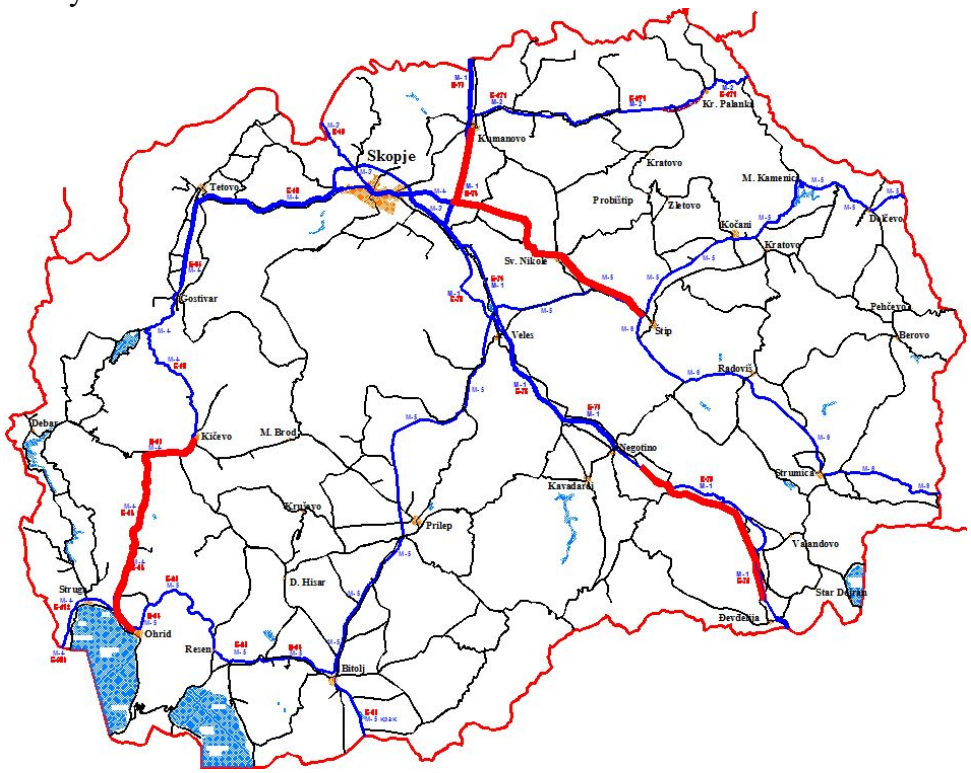
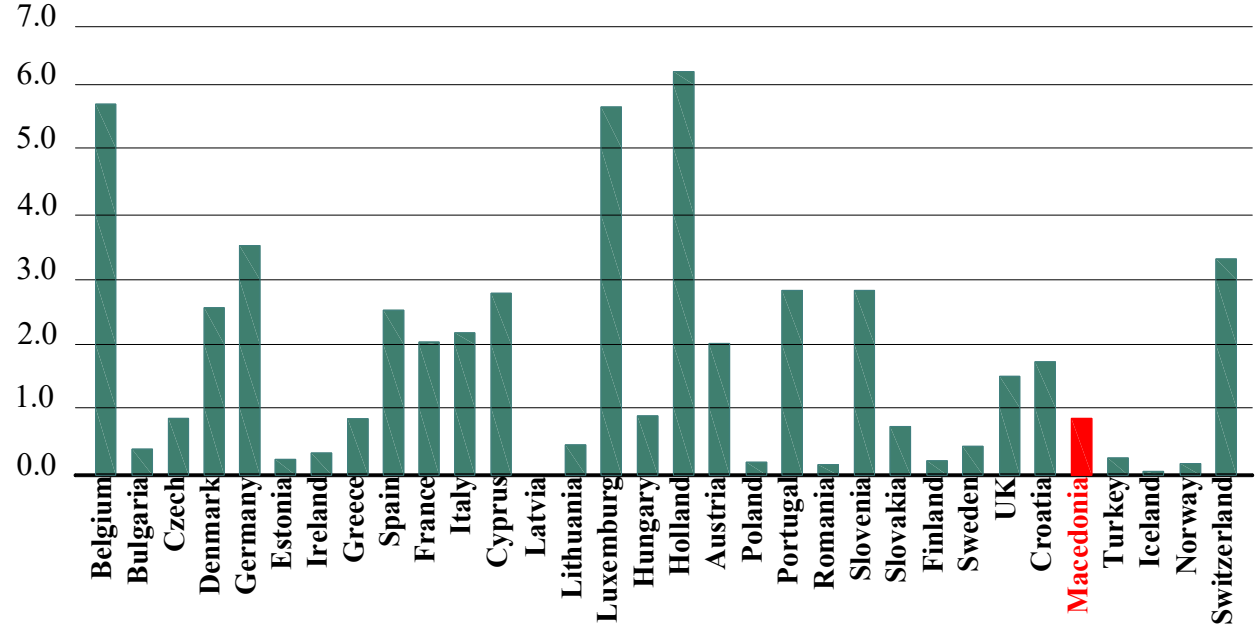


Fig. 1. Road network of the Republic of Macedonia

2. Present Condition

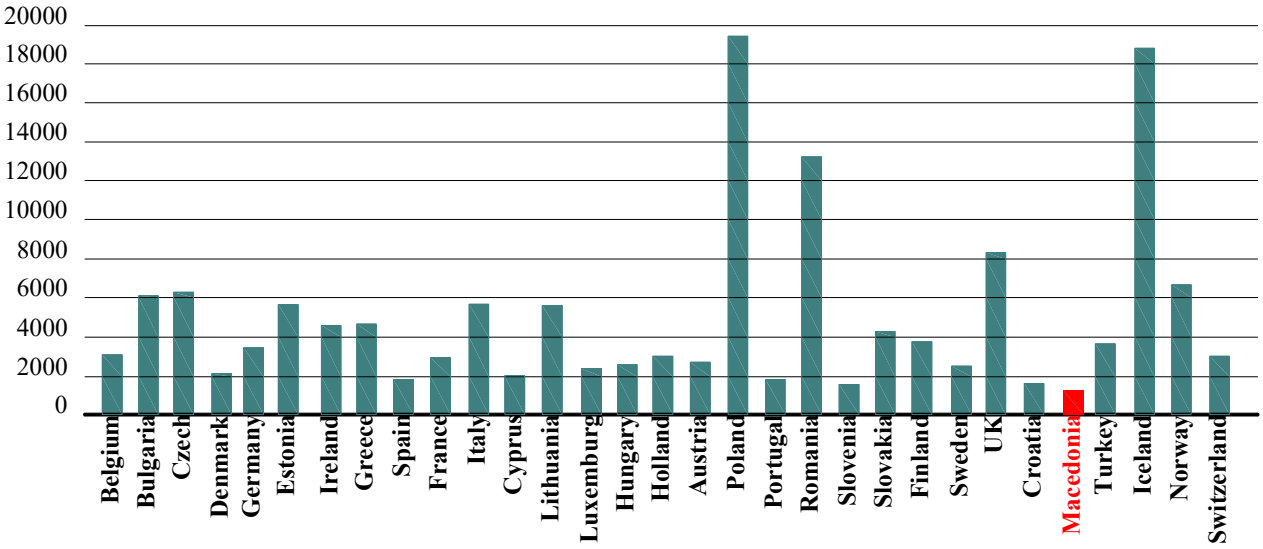
Pursuant to the data of the Public Enterprise of State Roads of Macedonia, the overall length of the state roads is of 4893.78 km of which 1112.27 km are main roads, 3645.20 km are regional roads, and the branch length is of 38.53 km and 97.98 km on the main and regional roads respectively (Figure 1). By adding the length of 9258km, which is the one of the local roads, we obtain the approximate overall length of all the roads in Macedonia, which is of 14252 km. Additional 132 km of highways are currently under construction: the Demir Kapija-Smokvica road which is around 28km in length, the road Miladinovci-Shtip (47km) and Kichevo-Ohrid (57km). Figure 1 shows the road network of the Republic of Macedonia.

Figure 2 gives a comparative demonstration of the highway density (number of highway kilometers on 100km2 of the country territory), and a comparative presentation of the motorization (number of registered passenger cars per km of highway, Figure 3).



Source: European Road Statistics за 2012 година

Fig. 2. Highway density in the European countries (km of highway/100 km^2)



Source: European Road Statistics за 2012 година

Fig. 3. Registered passenger cars per km of highway in the European countries (1000passenger cars/km of highway)

Pursuant to the European Road Statistics data of 2012 regarding the highway density related to the territory of the country, Macedonia belongs to the group of countries where the highway density is of medium level, with approximately 960m on a 100 km^2 of territory, which is a significantly better indicator that some EU countries (Bulgaria, Poland, Romania etc.). As for the motorization level, Macedonia is the last in Europe regarding the number of registered passenger cars and the length of its highway network, with 1255 cars per kilometer of highway. The example of Poland is especially interesting, as the highway density in that country is very low, meaning that the number of registered cars per highway kilometer is high, although Poland is characterized by a considerable economic growth. In other words, highways are not the key condition; a high-quality network of two-lane roads is perfectly able to support the crucial development of economic activities.

Supposing that the additional 132 km of highways currently under construction will be completed until 2020 sand that the level of motorization will increase at the annual rate of 3%, the length of the Macedonian roads would be of 1473m on the territory of 100 km^2, and 973 registered vehicles per kilometer of highway. In that case, the increase of the highway network would be considerably faster than the increase of the motorization level, which could be justifiable only if the entry and transit of foreign vehicles considerably increases in the several years to come.

3. Needs

On the macro level, the overall needs can be approximated though the increase of the number of registered vehicles and the level of their use, as well as the number of trans-border target and transit journeys of foreign registration vehicles. As the vehicles with foreign registration plates which spend some time on Macedonia using the road network for internal movements are not included, the so established needs reflect the lower limits. The level of use by the domestic vehicles, that is, the average annual mileage per vehicle is not an available data, but its approximate value can be indirectly established by the annual fuel consumption for traffic needs (Tables 1 and 2).

Table 1: Total number of registered vehicles in the period 2009-2013(motorcycles, passenger cars, heavy-duty vehicles, busses)

	2009	**2010**	**2011**	**2012**	**2013**
Motorcycles	9097	7761	8373	8473	8093
Passenger vehicles	282196	310231	313080	301761	346798
Heavy duty vehicles	27771	28795	27917	26542	30167
Buses	2454	2695	2636	2719	3022
Total	**321518**	**349482**	**352006**	**339495**	**388080**

Source: National Bureau of Statistics: Transport and other services 2013

Table 2: Fuel consumption in the period 2005-2010 (Diesel, LPG, petrol) in otns

	2005	**2006**	**2007**	**2008**	**2009**	**2010**
Diesel	184682	189314	218547	223186	247252	266687
LPH	27158	32378	43210	45687	44412	41807
Petrol	116527	106849	113603	117784	123324	123131
Total	**328367**	**328541**	**375360**	**386657**	**414988**	**431625**

It can be noticed that the number of registered vehicles in 2010 is 8.7% higher than the same number of 2009, and the fuel consumption in 2010 was 4% higher than in 2009. This means that although the number of registered vehicles (exception made for 2012), it seems that the increase of the fuel consumption does not follow that increase. It would be interesting to observe the relation of the number of registered vehicles and the fuel consumption in the period of 2011-2013, but there are no available data thereon. If the increase of the difference between the increase of the number of

registered vehicles and the fuel consumption continues, and considering that according to the National Bureau of Statistics of the Republic of Macedonia, the number of the vehicle over 10 years old amounts 78.2%, no increase of the traffic scope can be expected on our highways in the forthcoming period, at least regarding the number of vehicles with Macedonian registration plates. As for the trans-boundary traffic there are no available data on the vehicles with foreign registration plates with transit or target traffic on the territory of Macedonia. But the data on fuel consumption on the level of the rolling fleet of the EU demonstrate that the individual fuel consumption has been decreased from 8.25 l/100 km in 1995 to 7.2 l/100 km in 2010 (Energy Efficiency Trends in the Transportation in Europe, 2012). Also, the completion of the Romanian and Bulgarian highways and the commissioning of the Egnatia highway in North Greece on the one hand, and the two border crossings in Macedonia and Serbia (entry and exit of the transit traffic through the country), was not accompanied by any significant increase of traffic on our highways.

The average annual daily traffic (AADT) on the Macedonian highways is shown on Table 3. It is clear that, except on the Glumovo-Tetovo and Tetovo-Gostivar sections, the traffic load is under 10,000 vehicles/day both ways on all other sections. The increased load on these two sections is the direct consequence of the low mobility of the Macedonian population as a whole, the said mobility being increased on a local level, that is, on short relations on the Glumovo-Tetovo-Gostivar area. A similar situation can be observed on the area between Kichevo and Ohrid (where a highway is under construction).

Table 3: AADT on the Macedonian highways (vehicles/day/both ways)

Section	ПГДС (vehicles of all categories)
Border to the Republic of Serbia-Kumanovo	5254
Kumanovo-Miladinovci	8146
Miladinovci-Petrovec	6418
Petrovec-Veles	9213
Veles-Gradsko	5592
Gradsko-Negotino	3942
Demir Kapia-Udovo	4463
Smokvica-Gevgelija	4134
Gevgelija – border to Greece	7377
Skopje-Glumovo	9662
Glumovo-Tetovo	10631
Tetovo-Gostivar	12646
Gostivar-Kichevo	4634
Kichevo-Botun	4480
Botun-Podmolje	4539
Podmolje-Ohrid	9624

The situation is further complicated if an analysis is elaborated concerning the funds invested in regular maintenance. Table 4 gives data on the road maintenance funds on the level of the overall state road network in Macedonia.

Table 4: Data on the funds invested in the maintenance of the state road network in Macedonia in the period of 2005-2009.

Year	2005	2006	2007	2008	2009
Funds in EUR*	6	4	14	14	12
Average EUR/km	1226	818	2861	2861	2452

*million EUR

Source: European Road Statistics for 2012

Comparatively, the road maintenance funds in some countries in the region and in the European developed countries are given in Table 5.

Table 5. Data on the funds invested in road maintenance in some EU countries and in our region in the period of 2005-2009 (millions of sue)

	2005		2006		2007		2008		2009	
	EUR*	EUR/km	EUR*	EUR/km	EUR*	EUR/km	EUR*	EUR/km	EUR*	EUR/km
Croatia	242	12740	155	8160	158	8318	168	8844	144	7581
Slovenia	99	14612	140	20664	139	20516	148	21845	155	22879
Bulgaria			108	5582	215	11113	203	10493	69	3566
France	2189	5488	2235	5602	2294	5750	2184	5474	2207	5533
Switzerland	1520	76617	1534	77323	1410	71072	1608	81052		

*million of EUR

Source: European Road Statistics for 2012

Table 6: Length of the national road network in some EU countries and in our region

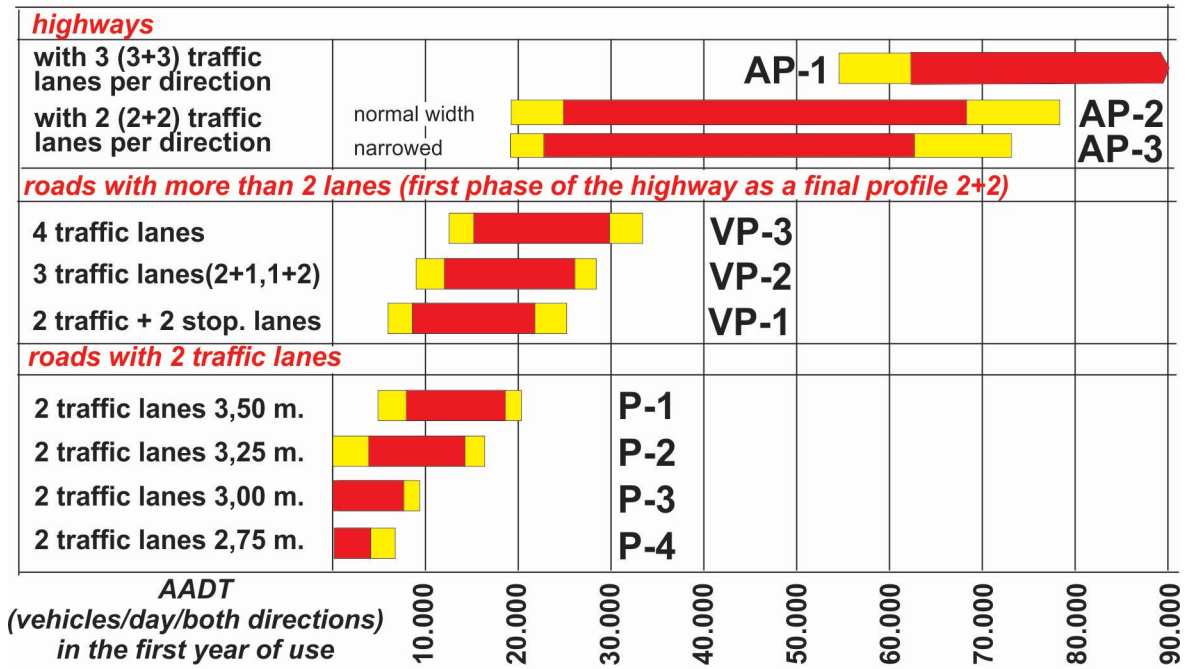
	Croatia	Slovenia	Bulgaria	France	Switzerland
Length in km	18996	6775	19347	398917	19839

Source: European Road Statistics for 2012

The tables clearly demonstrate that the funds invested in the maintenance of the Macedonian road network are far below the funds invested in the countries of the region, whereas the situation regarding the developed European countries is incomparable.
On the field, this means that winter maintenance of the highways is carried out as per the priority of the Public Enterprise of Makedonija Pat, including the reparation of the potholes, urgent cleaning of landslides, trimming of the grass at the flanks and along the central line, although not regular, renewal of the horizontal signaling. So, not a word about the application of any preventive maintenance measures. Namely, backfilling of cracks or any kind of surface treatment are not carried out on the Macedonian roads.
Rehabilitations are part of the investment maintenance and are subject to the same conditions as those applying to new roads, that is, they are financed through credits ad EU funds.

4. Possibilities

The principal benefits upon the construction of highways are the reduced expenses regarding the existing two-line road network, and above all, the time-related expenses of vehicle exploitation and the decrease in the expenses caused by road accidents. The direct income from the pay-tolls will have to cover the investment payment costs, as well as the costs on maintenance and pay-toll collection, control and processing. Of course, the expenses on highway building costs are always higher than those on a two-line roads, above all due to the considerably wider cross-section, the increased costs on expropriation and environment protection, the comfort elements of the site and leveling plan, the de-leveled intersections, the increased number of engineering constructions etc. Considering that the issue of economic justifiability is crucial in decision making, upper and lower limits are defined in many countries referring to the investment justifiability within the designing regulation framework. The Fig.4 chart is constructed as pursuant to the German and Serbian regulations. The lower limit is primarily established by the investment payment capacity, and the upper limit by the road capacity where the time dependent expenses exponentially increase.



According to RAS-Q 96 and Designing Rulebook, Official Gazette of Serbia 51/2011

Fig. 4. Limit values of the Average Annual Daily Traffic (AADT) as a basis to the justifiability of the investments in different road types

The low limit of the justifiability for the construction of a highway with two-lanes per direction (AP-2, AP-3, Fig. 4) can be expected at AADT=22000 - 25000 vehicles/day/two directions in the first year of exploitation. If this value is compared to the numbers of traffic on the Macedonian highways in 2012 (Table 3) it is clear that no section of the existing highways meets the justifiability criterion. Some of them even have three times lower traffic loads than the limit ones, and in fact create losses, that is, are prone to create losses that will have to be covered from the national incomes. What is yet more important, this criterion is not met even by the sections under construction. For example, the average load (AADT) of the road under the competence of the Croatian Highways, namely the Rijeka-Zagreb road, of 16,500 vehicles/day/two directions as in compliance with the data of 2012 generates annual losses in the approximate amount of 37,000,000 euro. The data concerning the average AADT of the roads of the Croatian roads (13200) and roads in Serbia (13,700) indicate that these networks under the competence of the respective country, create losses that are not known. The average annual daily traffic on the Macedonian roads for the year 2012 amounts 7702 vehicles/day/both lines. In the region, only Slovenia has a larger traffic scope, with AADT =29300 vehicles/day/both lines.

It is interesting to note that a high-quality road with two lines (P-1, Fig. 4) has an upper limit of justifiability at AADT =19000 - 20000 vehicles/day/both lines, that is, provides for economically acceptable exploitation conditions. This fact is very important when referring to pay-toll roads because, if the road is of a relatively good quality, parallel to a section of a highway, an important part of the users will still use the two-lane road in order to avoid the pay-toll, but the use of the highway by a large number of vehicles will create better conditions.

The multi-line roads (VP-1, VP-2, VP3, Fig. 4) are similar to highways by many important features, and they cover the traffic loads between the two-line roads and the highways. They can be a final solution when it can be confirmed with a relative certainty that no two-line highway per direction (2+2) will be necessary on those sections. Upon the staged construction of the highway with two lines per direction, a full-profile construction can be applied per sections when the traffic load approaches the upper load limit, for a two-line road; it is also possible to apply intermediate profile, that is, conditionally said, build half of the profile of a highway on several sections in continuity, so that the scope of the investments can be adjusted to the slower increase of the traffic needs with time. In such a case, all the elements correspond to a final highway profile, by

simultaneous pre-investment, for example, in expropriation, undercarriage, drainage, over-road constructions etc. As a consequence, the price of a staged building of a highway amounts 60-65% of the final building costs.

The crucial issue which is most frequently not addressed by the experts is the one of the increase of the traffic needs which are nowadays under the lower limit of justifiability of construction of highway sections. As it can be concluded from the above, it is not realistic to expect any serious increase of the traffic loads, that is, of the AADT, without a serious increase of the economic activities and people's standard, accompanied by some considerable increase in the mobility of the vehicles with domestic registration plates. On the other hand, no serious increase of the transit flows through Macedonia can be expected while there are border crossings where the time needed to control the vehicles, the passengers and the load (two border crossings) importantly increases the overall journey time, especially considering the construction of the highways through Romania and Bulgaria which shall take over an important part of the traffic flows of the vehicles with foreign registration plates.

Considering this, it is not realistic to plan that the Macedonian highway network will reach positive economic effects in the long run in future. In such a situation, which is not typical only for Macedonia, the budget funds for maintenance and rehabilitation are the first recourse at hand. Thus we are still faced with an impermissibly low level of funds for the maintenance of the existing road network, contributed by the traffic load of the existing highway network, which is considerably below the low limit of justifiability. As each serious concessionary knows the limit values of justifiability very well (Fig.6), the solution to this situation by issuing concessions for the existing highways will not be simple or easy.

Finally, there is one phenomenon that is, as a rule, characteristic of the medium developed European countries, not only of Macedonia, which is the emotional tendency of the polititians, professionals and the public to always entirely dedicate themselves to new buildings and large projects as highways are, neglecting the same, even maybe higher economic benefits that the country and society can reach by high-quality maintenance and rational reconstruction of all categories of existing roads as pursuant to their contribution to the economic and social development of the country.

As long ago as in 1881, A. Wellington, in his book entitled Economic Theory of Railway Location wrote his following attitude: *"It is unbelievable and discouraging how much the engineers, their teachers and employers pay attention to the smallest possible detail in the construction of a railway, forgetting more important issues regarding when, where and why to build"*

The present text is an attempt to actualize the questions of When? and Why? by rough and stubborn numerical data. Of course it is also an attempt to reduce the emotional "charge" and limit the intuitive determination as a precondition to a more rational decision-making, at present as well in the future.