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# **Long run impacts assessment of planned motorways and expressways in the Czech Republic**

Theme: ZK, SS – Long run impacts of major transport investments

## **Introductory notes and assessment methodology**

Assessing investment projects is undoubtedly an important instrument to increase the overall efficiency of private and public sectors. The main aim of this paper is to introduce a new methodology for assessment of the degree of necessity of public projects for constructions of transport infrastructure on example of selected motorways and expressways planned in the Czech Republic. It is necessary to point out that the “pragmatic” approach to this issue used so far prefers territorial readiness of constructions to an assessment of their necessity for the public. A rational solution of the issue is even more complicated due to the fact that the necessary complex approaches have not been developed sufficiently. Therefore, the practice still uses one-sided approaches whose main objective is to prove that the project is in harmony with the public interest and thus socially required.

The method most frequently used to measure the macroeconomic efficiency of public projects for transport infrastructure constructions is the cost-benefit analysis, which models the mutual relations of direct and indirect costs and benefits (see e.g. Florio et al., 2008). A geography based approach concentrates on an evaluation of the induced changes in accessibility (usually connected with an application of the gravity model). A common feature of both approaches is the emphasis on the evaluation of potential benefits which, however, has a partial character. Microeconomy oriented analyses of the efficiency of planned projects mainly reflect the specific conditions of the construction (including legislative conditions) and their main outcome is a calculation of the return on planned investment which is closely connected with an optimization of the cost-benefit ratio. Moreover, the informative value of economy oriented analyses is significantly affected by the quality of future development prognoses of the corresponding demand and other factors that are by nature uncertain. The above mentioned facts lead to the conclusion that the currently available methods do not allow us to gain complex information about potential social benefits of the development of transport infrastructure (see e.g. Atalik, Fischer, 2002), which negatively influences the efficiency of public financial means allocation within the field.

With respect to the limited budget sources, one of the essential tasks of the public

sector is to establish appropriate investment priorities based on an assessment of costs and benefits that should include the “production” of positive and negative externalities. Compared to the private sector, this is a considerably more complicated process as the non-market nature of a number of externalities disables their direct monetary valuation.<sup>1)</sup> In this context, we are of the opinion that analyses of the efficiency of transport infrastructure projects from the perspective of return on invested capital (especially studies of project feasibility) should be preceded by a multi-criteria analysis of the degree of necessity of their implementation for the public, including the related setting of ranking of individual projects within the selected criteria. In correspondence, the created methodology of comparative assessment of the degree of necessity of large projects of road infrastructure development (motorways and expressways, hereinafter M+E) endeavours to combine technical, economic, political, territorial and environmental aspects and therefore includes five basic criteria: relevance (traffic intensity), purposefulness (time saved), integration (strategic significance), stimulation (development impacts of the projects) and sustainability (environmental impacts of the projects).

The relevance criterion reflects the traffic intensity as a basic factor determining the technical necessity of M+E construction – the limit is usually an intensity of traffic flow of 20,000 vehicles/24 h, at which the capacity of roads of lower classes is depleted (which is connected with a considerable rise in the rate of traffic congestions). In this respect, it is necessary to consider both the current and the prospective traffic flows that depend on the development of economic and social indicators and other important quantities (economy structure, GDP development, price effects, population development, age structure of inhabitants, transport labour division, geographic location, etc.). However, most of these quantities are difficult to predict (in the case of long-term prognoses with the time horizon over 10 years these are rather qualified guesses or even mere deliberate speculations). As regards M+E, these prognoses are even more complicated due to the induced or additional demand – it is usually estimated that a 10% increase in investments in M+E is accompanied by an average increase in this demand by about 3.5% (Commission of the European Communities, 1994).

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<sup>1</sup> Besides the calculation of operational costs, the Czech system of road construction efficiency assessment elaborated by the Road and Motorway Directorate of the Czech Republic - ŘSD (based on the program developed by the Birmingham University) allows inclusion of some externalities only (time saved and accident rate).

The second criterion of purposefulness expresses the time saved in personal transport and haulage and its values are naturally related to traffic intensity. The appropriate absolute values are a primary basis for the following calculations of direct and indirect costs and benefits of M+E construction projects within the cost-benefit analysis (the value of time spent by travelling persons considered a negative externality is estimated by a large range of 10% to 50% of the corresponding value of working time in these analyses). Due to the already mentioned insecurity concerning future traffic flows it is useful to base the criterion application on relative values of potential time saved in personal transport and haulage (derived from design speeds established within particular M+E projects and respecting the general speed limits) reflecting the driving time related to the currently fastest road connection. From a general economic point of view, time saved has a positive effect on the limit of mobility of production sources because it contributes to the development of the territorial division of labour at different hierarchical levels (starting with labour markets).

The integration criterion reflects the strategic (political) significance of planned M+E projects for the spatial integration of the Czech Republic. In this context, it includes their potential benefits for an external integration (assessed from the perspective of providing a quality transport connection with neighbouring countries) as well as their potential benefits for internal integration (assessed from the perspective of providing quality transport connection of the most significant residential areas, mainly regional capitals). In the former case, an auxiliary criterion is the general significance position of the neighbouring countries for the development of Czech economy (generally, this is integration on the basis of business interactions). In the latter case, an auxiliary criterion is the population size of the regional capitals or their development position (regional capitals together with Mladá Boleslav are in the position of development poles and the most significant poles Prague and Brno are the main and secondary development poles of supranational significance, respectively – see Viturka, 2011).

The above described criteria are followed by two criteria focusing on an assessment of the most significant territorial impacts of M+E constructions. The stimulation criterion assesses the development impacts (positive externalities) and is based on the regional evaluation of the quality of business environment as an aggregate result of a long-term accumulation of various effects generated by activities of both entrepreneurial and non-entrepreneurial entities. The original methodology of assessment is based on identification of territory-bound factors reflecting investment and development preferences of companies within the bearing fields of economy (processing industry, higher market services). These are

16 trading, labour, infrastructure, local, price and environmental factors (for details see Viturka, Žitek, Klímová, Tonev, 2011). Out of these factors, the factor of quality of roads and railways is significant for our purposes. Its relative significance (weight) was set to 6% based on conducted analyses (particular road categories were allotted with significance weights reflecting their technical and economic characteristics ranging from 4.0 for motorways to 1.5 for 1<sup>st</sup> class roads; the corresponding proportions of road and railway transport in the transport labour division are considered in the ratio of 4 : 1). The actual assessment is based on the calculation of the contributions of the planned M+E construction projects to an increase in the quality of the specific factor from the perspective of specific microregions (the microregional level in the Czech Republic consists of 205 administrative districts of municipalities with extended competence of 3<sup>rd</sup> degree – MEC).

The sustainability criterion reflects the environmental impacts of M+E construction projects (negative externalities) and in this context it has obvious links to the long-term sustainability of social development. The regional assessment of environmental impacts considers road traffic effects (generated by noise and air pollution) on residential areas including the most significant leisure areas and effects on nature (mainly protected natural areas and areas of significant water resources). This is naturally a vastly generalized assessment corresponding to the established research aims (a detailed assessment is contained within EIA studies). The intensity of potential environmental impacts of the M+E construction projects is, besides the actual route of the road, affected by the traffic intensity and effects of many other (e.g. topographic and atmospheric) factors (based on analyses and the night limit of road transport noise of 45 dB, the contact zone was established to be 500 m far from edges of residential areas).

The final assessment of the evaluated M+E construction projects is based on non-weighted aggregations of their partial ranks gained within the set of the above described criteria. The resulting ranking represents synthetic information that allows for a qualified assessment of the degree of necessity of their implementation for the public and the following establishment of construction priorities.

### **Case study of the Czech Republic**

The first step of a practical application of the created methodology is naturally a relevant selection of projects to assess. In correspondence with approved routes set by the Ministry of Transport in cooperation with the Road and Motorway Directorate of the Czech

Republic (ŘSD), the selection consists of the following motorways (D) and expressways (R) or important parts of their planned routes over 50 km long.

**Tab. 1: Selected projects of motorways and expressways (D=motorway, R=expressway)**

name M/E	short description of the section	length in km
<b>D3</b>	Praha/Jesenice (crossing with R1) – Tábor – České Budějovice – Dolní Dvořiště/Austrian border (section from Třebonín proposed for construction as R3)	169
<b>D11</b>	Hradec Králové (Osičky) – Trutnov (section from Jaroměř proposed for construction as R11) – Královec/Polish border	70
<b>R6</b>	Nové Strašecí – Karlovy Vary – Cheb – Pomezí nad Ohří/German border (section from Cheb proposed as a two-lane expressway)	136
<b>R7</b>	Slaný – Chomutov – Hora Svatého Šebestiána/German border (section from Chomutov proposed as a two-lane 1 <sup>st</sup> class road)	82
<b>R35</b>	Turnov – Jičín – Hradec Králové/Pardubice (connection with D11) – Svitavy – Mohelnice (connection to the already constructed section of R35)	181
<b>R43</b>	Brno (Troubsko, crossing with D1) – Boskovice – Moravská Třebová (connection to the planned R35)	78
<b>R49</b>	Hulín (crossing with D1) – Fryšták/Zlín – Střelná/Slovakian border	70
<b>R55</b>	Olomouc (crossing with R35) – Přerov (section Přerov – Hulín in the planned route of D1) – Otrokovice/Zlín – Břeclav (connection to D2)	115

Source: ŘSD

The results of the first criterion application show that average intensity of traffic outside residential areas according to the data of road traffic census of 2010 (ŘSD, 2011) does not exceed the critical capacity limit of 20,000 vehicles/24 h in any of the planned routes. The highest average intensity of 14.1 thousand vehicles was recorded in the current roads within the route of planned R35 and the lowest intensity of 7.3 thousand vehicles within the route of planned R49 (the average of 92 selected profiles ranged around 10 thousand vehicles). For comparison, the average daily traffic intensity in the current motorways in 2010 was 27.6 thousand vehicles, in expressways it was 21.5 thousand vehicles and in 1<sup>st</sup> class roads it was 7.6 thousand vehicles. According to the data of ŘSD, the traffic intensity in main roads increased by about 90% between 1990 and 2005, but between 2005 and 2010 there was stagnation (with a decrease in haulage intensity). The current available prognoses of traffic intensity (ŘSD, 2010a-c) for roads D3, R7 and R35 are about 40–53 thousand vehicles in sections Praha – Benešov (D3) and Hradec Králové – Ostrov (R35) on the one hand and 10–12 thousand vehicles in Chomutov – Germany (R7) on the other hand in 2040. However, specific prognoses can differ substantially, e.g. EIA documentations expects 33.5–41.5 thousand vehicles daily in R35, section Ostrov – Janov, in 2025, while a more recent document of ŘSD expects almost identical values for the year 2040. Generally, the traffic

intensity is expected to rise continually between 2025 and 2040 (Bartoš et al., 2010). Many planned roads are assumed to be built using the PPP concept, in which, as for example M. Řežuchová (2010) pointed out, the most common cause of their failure is a wrong demand prognosis.

The second criterion provides basic information about potential time saved thanks to constructions of selected M+E. Its application is based on relative values interpreting the assessment of driving time saved in personal transport and haulage in percents (in all cases, the fastest connection found by map portal [www.mapy.cz](http://www.mapy.cz) was used as the initial input). The comparison of the current driving time and prospective driving time in planned M+E respecting the set basic reference values of average speed of cars – 120 km/h for motorways and 115 km/h for expressways (corresponding to the data from foreign studies, e.g. of Austrian institution Kuratorium für Verkehrssicherheit – see Tecl, 2006) shows that we can expect the highest amount of time saved (45–46% of driving time) in R55 and R49 and the lowest amount of time saved (21–26%) in the case of R7 and R6. The average amount of time saved is slightly below 31%. These are rough values only reflecting the physical and geographical conditions of the territory to some extent. The real values, besides individual factors, depend on operational and technical features of specific M+E.

From the point of view of supranational integration (integration on the basis of business interactions stimulated by the creation of a united European economic space), the most significant deficit is the missing motorway connection of the Czech Republic with Austria; this deficit should be removed by the construction of D3 towards Linz. In this respect, also the planned routes of D11 (connection with Poland – direction Legnica/Wrocław), R6 together with R7 (connection with Germany – direction Bayreuth or Chemnitz) and D49 (connection with Slovakia – direction Púchov/Žilina) are important. The planned M+E play a significant role in the internal integration as well (integration on the basis of production interactions induced mainly by the development of ‘agglomeration economy’). Within this context, the planned R35 (connection of two-core agglomeration Hradec Králové/Pardubice with Olomouc and also with Liberec) was assessed as the most important, followed by D3, R6 and R55. The best position within the criterion is held by D3 followed by R6 and the worst position is held by R43 followed by R49. In most cases it is necessary to assume an increase in the proportion of transit and induced traffic (see also Körner, 2010). There is a number of related issues, e.g. the motorway connection of Moravia with Austria either by a version with R52 (preferred by ŘSD and currently constructed between Brno and Pohořelice) or by extending the planned R55 (in the direction to Schrick and Wien). From the

perspective of the system, it is necessary to mention the development of the transport labour division between road and railway transport as the railways are still losing their share in spite of fees imposed on M+E (e.g. in the case of haulage this share dropped from 77% in 1989 to the current 24%).

The synthetic criterion focusing on the assessment of economic impacts interprets the potential effects of M+E construction projects as one of traditional stimuli of regional development. Implementation of all the selected projects would affect economic development of 47 MEC regions (23% of all). The most significant impact, in dependence on the calculated percents of the improvement of the factor weighted by the number of inhabitants of specific MEC regions, have been found for R55 (by 8.7 converted points for 9 regions), R35 (by 5 points for 10 regions) and D3 (by 4.5 points for 6 regions); the lowest level of impact was found for R7 (by 2.5 points for 4 regions), R43 (by 3.1 points for 5 regions) and D11 (by 3.7 points for 4 regions). It is also important to note that M+E construction most stimulates the development of smaller intermediate regions – in our case these are mainly regions of Moravská Třebová (improvement of non-weighted values of factor by 151%), Dvůr Králové nad Labem (136%), Rakovník (111%), Valašské Klobouky (91%) and Vizovice (88%). As regards regional capitals, a considerable or obvious improvement of the factor can only be expected in the cases of Zlín, České Budějovice and Hradec Králové. Out of the regions affected by the planned M+E, the lowest overall quality of business environment is in the Ústecký, Olomoucký and Zlínský regions – construction of R7, R35, R49 and R55 can considerably contribute to a reduction of these negative disparities (see Víturka, Žitek, Klímová, Tonev, 2011). Generally, the greatest synergic effects can be expected where M+E projects correspond with the current or potential development axes of national or regional significance. This mainly concerns the stimulation of the prospective northern Bohemian-Moravian development axis of national significance Praha – Pardubice/Hradec Králové – Olomouc in the interaction with the construction of R35. On the other hand, it is necessary to mention the empirically verified experience that M+E construction deteriorates the economic situation of peripheral areas located outside the main transport corridors (transition of economic activities towards these corridors).

The second synthesizing criterion focuses on an aggregate assessment of potential environmental impacts of M+E projects on living and natural environment. Regarding the living environment, the largest negative impacts are related to roads constructed or planned over centres or residential areas of cities and towns. Examples are R43 with the route proposed through city part Brno-Bystrc (about 30 thousand inhabitants threatened as well as



the probably most important leisure area of Brno), R6 with an already constructed section through Karlovy Vary (a similar level of threat) and R35 with an already constructed section through Turnov (about 10 thousand inhabitants threatened). R49, D11 and R7 are the least controversial as only limited negative effects are expected generated by their routing in the contact zone of towns with over 5 thousand inhabitants. When assessing the impacts on the natural environment, our attention focused on identification of possible conflicts between the planned M+E and protected areas of European and national significance (the used information sources were [www.geoportal.gov.cz](http://www.geoportal.gov.cz), Nature Conservation Agency of the Czech Republic - AOPK ČR and T. G. Masaryk Water Research Institute - VÚV TGM). This concerns the following categories: Sites of Community Importance (SCI) including bird sanctuaries, Special Protection Areas (SPA), Supra-regional Territorial Systems of Ecological Stability (in Czech NÚSES), Protected Areas of Natural Water Accumulation (in Czech CHOPAV), and Water Source Protection Zones (in Czech OPVZ); for the first two categories we respected the established contact zone of 500 m, for the others we investigated the overlapping of the planned route with the area. Regarding SCI and SPA (protected landscape areas, national nature reserves, national nature monuments, nature reserves, and nature monuments) we assessed whether the planned route goes directly through or whether the contact zone is disrupted. Regarding NÚSES, we explored the absolute number of potential collisions; regarding CHOPAV and OPVZ we investigated the total length of collision sections. The obtained results indicate that the least controversial project is R7 and the most controversial is R35. Based on an overall assessment of environmental impacts (average of both partial criteria), the best positions are held by R49, R7 and D11; on the other hand, R35 and R6 are the worst.

The complex assessment of selected M+E construction projects was conducted using aggregation of the partial ranks of these projects within the criteria. The results of the multi-criteria analysis show that the best positions within the eight assessed M+E projects are held by R55, D3 and R35. The high degree of necessity of their construction for the public has been proved (the average score within the established criteria ranges between 2.6 and 3.8; only in four cases their place was worse than fourth). However, this does not mean that these are project with no problems at all. Especially R35 manifests the worst place within the environmental impacts criterion due to its controversial routing in the area of the Protected Landscape Area Český ráj. There are three routing versions proposed: the southern one, the northern one that is preferred by ŘSD, and the 'super-northern' one; the southern version seems to be the least controversial concerning the environment. Also D3 faces substantial

problems in the area of Posázaví – two versions are proposed: the ŘSD prefers the western version and there is also an eastern version; both get in contact with an area intensively used for leisure. Similar problems can also be found in the case of R55 because its route leads through a bird sanctuary and two other SPAs in its Bzenec – Rohatec section. Two versions were proposed: the surface unroofed version, (probably the most suitable) surface roofed version, and a tunnel version. The second group of disputable projects consist of D11 and R49 (an average score of 4.6; in total, their place was worse than fourth in 6, i.e. 60% of cases). The degree of necessity of their construction is negatively affected by relatively little time saved and low economic impacts (D11) or a very low traffic intensity and a small strategic significance (R49). The necessity of the construction of the remaining projects R6, R7 and R43 has not been proved (the average score ranges between 5.4 and 6.0; in total, the place was worse than fourth in 10, i.e. about 2/3 of cases). Their necessity is especially doubtful due to the comparably lowest economic impacts and a low strategic significance (R43, R7), a low traffic intensity and negative environmental impacts (R6 and R43), or little time potentially saved (R7). From the point of the view of the system, it is necessary to note that the final ranking of M+E shows the strongest links with the criterion of regional development stimulation (coefficient of correlation 0.93). The weakest (negative) links are related to the criterion of development sustainability.

**Tab. 2: Results of the necessity of road constructions (ranking of projects)**

selected M+E	relevance	purposefulness	integration	develop. stimulation	develop. sustainability	sum of ranks	total ranking
<b>R 55</b>	3	1	5	1	4	14	1
<b>D 3</b>	2	5	1	3	5	16	2
<b>R 35</b>	1	4	4	2	8	19	3
<b>D 11</b>	5	6	3	6	3	23	4-5
<b>R 49</b>	8	2	7	5	1	23	4-5
<b>R 6</b>	7	7	2	4	7	27	6
<b>R 7</b>	4	8	6	8	2	28	7
<b>R 43</b>	6	3	8	7	6	30	8

Source: author's own research

## Conclusion

Implementation of large transport infrastructure construction projects is usually justified in many countries including the Czech Republic by a general indication of their broad economic benefits, which are not further specified or are specified partially. One of the significant causes of this approach is the non-existence of an empirically sufficiently verified

model for a complex assessment of their potential social benefits. The presented paper introduces an original method for comparative assessment of the necessity of planned road construction projects which allows us (in spite of a number of simplifying assumptions, e.g. not considering the alternative of railway transport) to obtain information necessary to evaluate the degree of necessity of the road infrastructure projects for the public in the Czech Republic, based on which relevant priorities can be established (the practical desirability of these analyses is emphasized by the fact that the current price for a kilometre of a Czech motorway reaches to a hardly acceptable level of 450 million Czk, according to ŘSD). Generally, the elaborated method can be considered a contribution to the reduction of the existing deficits in the given field of research.

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