

# Quantification of the noise charges for the selected road network sections

Martina Margorínová<sup>1,\*</sup>, Marjan Lep<sup>2</sup>, and Mária Trojanová<sup>1</sup>

<sup>1</sup>Department of Construction Management, Faculty of Civil Engineering, University of Žilina, Univerzitná 8215/1, 010 26 Žilina, Slovakia

<sup>2</sup>Faculty of Civil Engineering, Transportation Engineering and Architecture, University of Maribor, Smetanova 17, 2000 Maribor, Slovenia

**Abstract.** Road traffic is the most used kind of transportation which has a lot of benefits. Except of these benefits, the road traffic causes a lot of negative impacts like a congestions, air pollution and noise. The proposal of European Parliament is reduction of these impacts by their inclusion to the road charges. In the annex of amending directive 1999/62ES are stated prices for congestion and external costs. If the member state wants higher amount like are stated, they have to be calculated. One element of external costs is noise costs. Noise from road transport causes health problems and has annoying effect to people. In this article, it was processed proposal of noise charges quantification, which consist of a few steps. This process was applied for quantifying noise charges with real values for Slovakia and Slovenia.

## 1 Introduction

Using of road infrastructure brings to society considerable costs. They are caused mainly by congestions, noise and air pollution. Current charging of roads does not reflect real costs of roads use. The proposal of European Parliament is inclusion these external costs to charging roads as a tool for their reduction. This proposal is listed in proposal of amending directive 1999/62ES about charging of heavy goods vehicles for the use of certain infrastructures. In annex of amending directive gives the references amount of fee for congestion, noise and air pollution.

The one element of the external costs is noise costs. The noise can be defined as the unwanted sound which causes physical or psychological harm to humans. Road traffic noise has disturbing effects and causes discomfort, inconvenience and health damages. The proposal of the directive is to charge roads where are the noise levels too high and have negative impact on people. This noise charging should be a tool for noise reduction from road traffic on specified roads sections. Inter alia, the higher fees of road charging will bring higher amount of financial funds to the state which may be used for improvement of road infrastructure. In case when the state wants to apply higher amount of fee of external costs than are given in the annex, the amount has to be computing. In the annex of the

---

\* Corresponding author: [martina.margorinova@fstav.uniza.sk](mailto:martina.margorinova@fstav.uniza.sk)

directive are listed conditions and equation for their quantifying. In this article is processed the proposal of noise charges quantification. This proposal was processed in a several steps, which are based on equation from the annex. The proposal of quantification was applied on real example and the final noise charges were calculated for Slovakia and Slovenia.

## **2 Current charging of road infrastructure in Slovakia**

Charging of road infrastructure in Slovakia is divided according type of vehicle, i.e. for light and heavy cars. The light cars (max. to 3,5 tons) have to have electronic vignette. This vignette is necessary for motorways and expressways. At present are available three options of motorway vignettes: 10 days, 30 days and 1 year vignette. The heavy cars (more than 3,5 tons) have to pay electronic toll. 9

The toll is the payment calculated electronically according travelled distance. The prices are listed in € per kilometre. Prices are divided according vehicle category (lorries and buses), emission class and number of axles. The amount of toll rates depends also from road category. The toll rates are divided for three categories: Motorways and Expressways, I. class roads parallel to motorways and expressways and I. class roads not parallel to motorways and expressways. The II. and III. road class are not charged in Slovakia. 9

## **3 Proposal of the amending directive**

The proposal of the amending directive 1999/62/ES is fairly charging of road infrastructure. At present, toll in EU is fragmented and almost at all does not reflect real costs of road using. The aim of this proposal is to promote sustainable and equitable road transport by principles “user pays” and “polluter pays”. The main negative impacts from road transport, which should be charged, are congestion, noise and air pollution. This charging should be effective tool for their reduction. 1 2

### **3.1 Minimum requirements of external costs charging**

In annex (IIIa) of the DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL amending Directive 1999/62/EC on the charging of heavy goods vehicles for the use of certain infrastructures, are stated minimal requirements for levying an external-cost charge. If member state wants higher charge of external costs, they have to be quantifying according stated requirements for quantifying maximal charge of external costs stated in this annex. 1 2

#### **3.1.1 Charged elements of external costs**

The proposal is reduce negative impact form road transport. The main negative impacts, which affect human health and environment, are air pollution and noise. These elements of external costs are proposed for roads charging. 1

#### **3.1.2 The charged parts of road network**

The member state defines part or parts of road network which will be charged. These parts shall be chosen after an assessment establishing, where will be investigated if:

- the use of roads by vehicles cause damages the environment more than average of this assessed damages (in accordance with reporting of air quality, national emissions and noise, in accordance with Directive 2002/49/EC), or

- the introduction of external costs charges might have adverse effects on the environment and road safety, or levying and collecting an external-cost charge on them would entail disproportionate cost. 2

### 3.1.3 The charge amount

In the annex IIIb of the amending directive are stated reference values for external costs charge. These values include together costs of noise and air pollution. In annex IIIb are two tables: the first table is for heavy goods vehicles and the second is for coaches. The reference values are divided according vehicle class (weight in tons and number of axles), emission class (EURO 0, I, II ...) and locality (suburban and interurban). The suburban areas means areas with a population density between 150 and 900 inhabitants per km<sup>2</sup> and the interurban areas means areas with a population density below 150 inhabitants per km<sup>2</sup>. The reference values are stated in € cents per vehicle kilometre. In next table is showed part of reference values of external costs charge for heavy goods vehicles. 2

**Table 1.** The part of reference values of external costs charge for heavy good vehicles

Vehicle class	cent/vehicle-kilometre	Suburban(1)	Interurban(2)
max. permissible gross laden weight of less than 14t or having 2 axles	EURO 0	13.3	8.3
	EURO I	9.1	5.4
	EURO II	8.8	5.4
	EURO III	7.7	4.3
	EURO IV	5.9	3.1
	EURO V	5.7	1.9
	EURO VI	3.2	0.6
	Less polluting than EURO VI	2.5	0.3
max. permissible gross laden weight between 14 and 28 tonnes or having 3 axles	EURO 0	23.3	15.1
	EURO I	16.4	10.1
	EURO II	15.7	10
	EURO ...	...	...

If the member state wants higher amount of charge than reference values, the amount will be quantified according requirements for calculating the maximum external-cost charge stated in annex IIIa. [2]

### 3.2 Proposal of quantifying higher amount of noise charge

In general, the noise causes health problems and has annoying effects for people. The road transport is the one of the main resource of noise. The proposal of European Parliament is to reduce noise from road, and thereby reduce damages of health like a cardiovascular diseases, increase blood pressure, nervous stress issues, etc. This reduction should be reached by road charges. The result of the quantifying is to determine single specific amount for each vehicle class, type of road and time period. The resulting charging structure shall be transparent, made public and available to all users on equal terms. All parameters, data and other information, which are necessary for understanding method of calculation amount of noise costs, have to be published. 1 2

The stated prices in the annex IIIb are sum of external costs, i.e. noise and air pollution costs. When the state wants higher amount of charge than are stated, they have to be quantifying according requirements listed in annex IIIa. When setting the charges, the Member State or, where appropriate, an independent authority shall be guided by the

principle of efficient pricing that is a price close to the social marginal costs of the usage of the charged vehicle. For quantifying noise charges are stated in the annex IIIa following equations. 2

$$NCV_j \text{ (daily)} = e \cdot \sum_k NC_{jk} \cdot POP_k / WADT \quad (1)$$

$$NCV_j \text{ (day)} = a \cdot NCV \quad (2)$$

$$NCV_j \text{ (night)} = b \cdot NCV_j \quad (3)$$

Where: NCV<sub>j</sub> noise costs of one heavy goods vehicle on road type „j“ [€/vkm]  
 NC<sub>jk</sub> noise costs per person exposed on road type „j“ to noise level „k“ [€/person]  
 POP<sub>k</sub> population exposed to daily noise level „k“ per kilometre [person/km]  
 WADT weighted average daily traffic [passenger car equivalent]  
 „a“ „b“ are weighting factors determined by the Member State in such a way that the resulting weighted average noise charge per vehicle kilometre corresponds to NCV<sub>j</sub> (daily). [2]

The noise pollution from the road traffic relates to the impact on citizens health around the roads. The process of quantifying noise charges from road transport is based on the equation (1). According this equation and requirements listed in the annex IIIa were processed steps for the quantification of noise charges which are showed below. 2

### 3.3 Steps for quantification of noise charges

Here are showed suggested steps for quantification of noise charges, in case, when the member state wants higher amounts of noise charges.

#### 1. STEP - choice of road section

Member state shall determine each road sections, where will be applied noise charges. The proposal is that these road sections will be chosen according strategic noise maps. Every member state has to have strategic noise maps according directive 2002/49/EC. These maps have been made for roads, where the annual road traffic is more than 6 million vehicles. On this base, state shall determine areas with the high noise levels, where the people and inhabitants are considerable affected.

#### 2. STEP – amount of people exposed to road traffic noise

Information about noise exposed people will be taken from strategic noise maps. The amount of exposed people will be divided according noise classes. The noise classes are determined by noise levels: 55-59 dB, 60-64 dB, 65-69 dB, 70-74 dB and more than 75 dB. The exposed people of noise will be stated in number per kilometre of road for each noise class. 4

#### 3. STEP – the value of costs for noise exposed people

The value of costs per exposed person will be estimated by the member state or using scientifically proven methods. At present, there are a many methodical handbooks for noise costs in EU, for example:

- HEATCO - Developing Harmonised European Approaches for Transport Costing and Project Assessment, 2005. 5
- Ce Delft - External Costs of Transport in Europe, update study, 2011. 3
- RIACRDO-AEA, Update of the Handbook on External Costs of Transport, 2014. 4

These handbooks are for valuation all kinds external costs not only noise costs. The newest handbook is from 2014 – RIACRDO AEA. In general, there are exists two approaches for noise costs valuation. The first is approach BOTTOM UP. In this approach are given prices in € per 1000 vehicle kilometres. The prices are divided according car type, time of day, traffic density and locality. The second is TOP DOWN approach. This approach is

valuated total impact of road traffic to exposed people. The values are stated for each noise class and for each member state EU. The prices are stated in € per person per year. The prices in mentioned handbooks (Ce Delft and RICARDO AEA) are taken from HEATCO. In next figure are prices from RICARDO AEA handbook. 4, 5

Country	Lden, dB(A)					
	=51	=55	=60	=65	=70	=75
France	10	52	106	158	212	351
Germany	12	61	120	181	242	402
United Kingdom	12	59	120	179	238	397
Spain	8	39	78	117	156	259
Italy	9	45	90	135	180	298

Fig. 1. Cost prices for noise exposure [€ per person per year], 4

The prices from TOP DOWN approach can be used for quantifying noise charges. The listed prices are from year 2010. It is necessary these prices edit to the current year. It will be made according GDP growth per capita of the member state.

4. STEP – traffic intensity

Traffic intensity is another important parameter for quantification noise charges. Every member state has information about road traffic on road network. In the equation 1 is stated average daily traffic - ADDT in passenger car equivalent - WADT. The recalculation to passenger car equivalent will be done by conversion factors. At the next table are stated the calculation coefficient which are from Technical conditions TP 102 of Slovak Road Administration. 7

Table 2. Recalculation coefficient to passenger car equivalents

Type of vehicle	Cyclist	Motorcycle	Passenger cars	Truck	Heavy goods vehicle1
Calculation coefficient	0.5	1.0	1.0	1.5	2.5

Note: In special cases, after weighing the length of the kits, a conversion factor of 3 is allowed.

5. STEP – costs allocation for each vehicle type

The results of this quantification are costs for each vehicle class for urban and suburban locality. In general, heavy vehicles cause higher level of noise than passenger cars. It is necessary take into account this fact. Quantification the amount for each vehicle class will be done by weighting factors. These weighting factors are also stated in mentioned handbooks of external costs. At the next table are stated weighting factors for each vehicle class which are divided to urban and suburban roads. 4 6.

Table 3. Weighting factors for each vehicle class, 6

Road	Urban (50 km/h)	Other roads (80 km/h or higher)
Passenger car petrol	1,0	1,0
Passenger car diesel	1,2	1,0
Passenger car LPG	1,0	1,0
Moped	9,8	3,0
Motorcycle	13,2	4,2
Bus	9,8	3,3
Van	1,5	1,2
HGV solo < 12 ton GVW	9,8	3,0
HGV solo > 12 ton GVW	13,2	4,2
HGV with trailer	16,6	5,5

6. STEP – quantification of noise charges per each vehicle class

After obtain all necessary data according equation 1, it is possible to quantify noise charges for each vehicle class. Besides that, the state can divide the noise charges for a day and night time. It will be done according equations 2 and 3, where are stated weighting factors "a" and "b". The member state will determine these factors. The final results of this

quantification are noise charges for each vehicle type for urban and suburban areas. The prices are stated in € per vehicle kilometre respectively € cents per vehicle kilometre.

### 3.4 Example of quantification of noise charges for Slovakia and Slovenia

For better understanding, the example of noise charges quantification is listed below. The noise charges were quantified for two countries: Slovakia and Slovenia. This quantification was made in the excel software. Input parameters about road, exposed people and traffic intensity are fictional (these data are not from real road section). These data are same for both countries. Data about noise costs, weighting factors and real DGP growth are real according stated data for both countries. The used data are listed below.

#### 3.4.1 Data about road communication and traffic intensity

The type of road is I. class road. The road length is 6 kilometres and it is situated in urban area. In table 4 is listed average daily traffic (AADT) and its recalculation to passenger car equivalent (WADT). The recalculation coefficients are from technical conditions TP 102 of Slovak Road Administration. 7 Data about road communication and also data about traffic intensity are fictional.

**Table 4.** Average daily traffic recalculated to passenger car equivalents

Type of car	AADT		calculation coefficient	WADT	
passenger cars	16 000	vehicles/day	1.0	16 000	vehicles/day
motorcycle	40	vehicles/day	1.0	40	vehicles/day
buses	700	vehicles/day	1.5	1 050	vehicles/day
HGV < 12 t	2 300	vehicles/day	1.5	3 450	vehicles/day
HGV > 12 t	1 800	vehicles/day	2.5	4 500	vehicles/day
HGV with trailer	700	vehicles/day	3.0	2 100	vehicles/day
<b>Σ AADT</b>	<b>27 140</b>	<b>vehicles/day</b>	<b>Σ WADT</b>	<b>27 140</b>	<b>vehicles/day</b>

#### 3.4.2 Data about exposed people of traffic noise

Here are listed data about number of exposed people according noise classes. These data are stated for whole road length and data recalculated to per 1 km of road. These data are also fictional.

**Table 5.** Number of exposed people to whole road length and per 1 km

Noise class	51-54 dB	55-59 dB	60-64 dB	65-69 dB	70-74 dB	More than 75 dB
Number of exposed people in area - whole road (6 km)	6000	7800	2000	400	300	200
Number of exposed people per 1 km or road	1000	1300	333	67	50	33

#### 3.4.3 Data about data about price of one exposed person to traffic noise

This data are from handbook of external costs - RICARDO AEA. The stated prices are for Slovakia and Slovenia for the year 2010. The stated prices are form year 2010. For each noise class are stated individual prices. 4

**Table 6.** The prices of noise costs for Slovakia and Slovenia per each noise class

Country	noise classes, Lden, dB(A); € per person per year; 2010					
	51-54 dB	55-59 dB	60-64 dB	65-69 dB	70-74 dB	More than 75 dB
Slovakia	3	15	29	44	58	97
Slovenia	5	27	55	82	109	181

These prices are necessary edit to actual year according to the growth of real gross domestic product per capita with elasticity 0.7. The values for GDP growth per capita for both countries were taken over from EUROSTAT website. 8

**Table 7.** The growth of GDP per capita for Slovakia and Slovenia

	Real GROWTH GDP per capita							GROWTH
	2011	2012	2013	2014	2015	2016	2017	
Slovakia	3.4	1.5	1.4	2.6	3.8	3.2	3.3	1.1864
Slovenia	0.5	-2.9	-1.3	2.9	2.2	3.1	4.9	1.0737

The noise costs were edited after the GDP growth had been quantified. The edited prices are listed in table 8.

**Table 8.** Edited prices for Slovakia and Slovenia

Country	noise classes, Lden, dB(A); € per person per year; 2017					
	51-54 dB	55-59 dB	60-64 dB	65-69 dB	70-74 dB	More than 75 dB
Slovakia	3.6	17.8	34.4	52.2	68.8	115.1
Slovenia	5.4	29.0	59.1	88.0	117.0	194.3

### 3.4.4 Weighting factors

The weighting factors were taken from handbook of external costs. In the table 9 are stated values for urban area.6

**Table 9.** Weighting factors for urban area per each vehicle type

type of car	Urban area (50 km/h)	type of car	Urban area (50 km/h)
passenger car petrol	1.0	Bus	9.8
passenger car diesel	1.2	Van	1.5
passenger car LPG	1.0	HDV solo < 12 t	9.8
Moped	9.8	HDV solo > 12 t	13.2
Motorcycle	13.2	HDV with trailer	16.6

### 3.4.5 Quantification of noise charges for Slovakia and Slovenia

The quantification was made in excel software according the stated equation 1. Noise charges were quantified after the all necessary data had been inputted. In next table (Table 10) are stated prices for noise charges in € cents per vehicle kilometre for each vehicle type. In a last column of table 10 are stated difference between values of countries.

**Table 10.** Final prices of noise charges per each vehicle type for Slovakia and Slovenia

type of car	Urban - 50 km/h (€ cents/vkm)		
	SLOVAKIA	SLOVENIA	Difference of values
passenger car petrol	0.49	0.82	0.33
passenger car diesel	0.59	0.98	0.39
passenger car LPG	0.49	0.82	0.33
Moped	4.84	8.00	3.16
Motorcycle	6.51	10.78	4.27
Bus	4.84	8.00	3.16
Van	0.74	1.22	0.48
HDV solo < 12 t	4.84	8.00	3.16
HDV solo > 12 t	6.51	10.78	4.27
HDV with trailer	8.19	13.55	5.36

## 4 Conclusion

The proposal of noise costs charging has its justification. Noise causes health problems and has annoying impacts to inhabitants. The implementation of noise charges has an importance mainly in inhabited areas, where road traffic causes high levels of noise. In case, when the stated prices in annex IIIb are not adequate, it is necessary quantify noise charges according equation stated in annex IIIa.

The stated equation for noise charges looks simple, but it requires necessary a lot of data for its quantification. The data are about road communication, traffic intensity, noise levels, number of exposed people, noise costs, etc. Every member state should has available these data. For example, the data about exposed people to noise will be taken from strategic noise maps, which are compulsory for roads with annual road traffic more than 6 million. These maps are obligatory for member states according directive 2002/49/EC.

The main objective of this article was processing the proposal of quantification of noise charges. This quantification was processed in few steps, which were applied to real quantification of noise charges for Slovakia and Slovenia. The difference in quantification was in used noise costs and growth of GDP per capita. The results of this quantification are noise charges for both countries. According these results, we can say, that Slovenian noise charges are higher than Slovak. This is caused by higher input data of noise costs.

## References

1. European Commission. Commission staff working document, Impact assessment. Accompanying the document. Proposal for a Directive of the European Parliament and of the Council amending Directive 1999/62/EC on the charging of heavy goods vehicles for the use of certain infrastructures and Proposal for a Council Directive amending Directive 1999/62/EC on the charging of heavy goods vehicles for the use of certain infrastructures, as regards certain provisions on vehicle taxation, SWD (2017) 180 final, 3, (2017)
2. European Commission. Annex of the directive of the European parliament and of the council amending Directive 1999/62/EC on the charging of heavy goods vehicles for the use of certain infrastructures, COM (2017) 275 final, 12 (2017)
3. H. Essen. et. al. External Costs of Transport in Europe. Delft. Pg. 161 (2011)
4. A. Korzhenevych et. al. Update of the handbook External Costs of Transport. European Commission – DG Mobility and Transport, 139 (2014)

5. S. Navrud et al. HEATCO – Developing Harmonised European Approaches. for Transport Costing and Project Assessment. Norway: European Commission, 176 (2006)
6. M. Maibach. et. al. Handbook on estimation of external costs in the transport sector. Version 1.1. Delft, CE, 336 (2008)
7. Slovak Road Administration. Technical conditions: TP 102 - Calculating of the road communications capacity, 204 (2015)
8. Website of EUROSTAT: <http://ec.europa.eu/eurostat/data/database>
9. Website of Slovak National Highway company: <https://www.ndsas.sk/en>