

Assessment of External Transport Costs from Air Pollution in Republic of North Macedonia

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Abstract – The objective of this paper is to present the assessment of external transport costs in Republic of North Macedonia from air pollution. Externality is a cost or benefit that is transferred and affects other parties that are not directly related to the project, but they are not financially compensated. The approach for evaluation of monetary values of transport air pollution is based of estimation of these costs in relevant EU studies.

Keywords – External costs of transport, air pollution

I. INTRODUCTION

Externality (or external effect) is a condition that occurs in production or consumption activities of a given entity that affect the welfare of another entity(s) without paying compensation for that effect. One externality has two important characteristics. On the one hand, externality creates a secondary effect that is seen as an external consequence of the main production or consumption activity, and on the other hand, the interaction between the creator and the recipient of that effect is not accompanied by any market exchange. Environmental pollution is a typical example of negative externalities. Transport activities greatly affect the quality of the environment and the quality of life of humans and animals. This is an interest for studying the externalities of transport and particularly to focus on how to reduce these negative externalities. This paper will consider the external costs of transport, their significance and their monetary value in Republic of North Macedonia. Reference documents of European Union are used in assessment methodology.

II. PREVIOUS ASSESSMENT OF EXTERNAL COSTS OF TRANSPORT IN EU

The first research and assessment of external costs of transport in European countries are made by International Union of Railways (UIC) and the document Green Transport Reducing

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External Costs is published in 2012 [1]. The approach to determine the value of external costs of transport in this paper uses a methodology to assess value of non-market goods. The HEATCO research project under the 6th EU Framework Program 2002-2006 for harmonization of European practices in the estimation of transport costs and project assessment, gives particular attention for estimation of the external cost of transport in the EU countries [2], [3]. Internationalization of External Transport Costs is presented in the study developed by CE Delft and published in the Handbook [4] supported by the European Commission in 2008. The update of this study is carried out in 2011 [5]. The cited Handbook was updated also in version from 2014 taking in account new input values [6]. The last edition of the Handbook of the external costs of transport is published in 2019 by European Commission [7].

III. METHODOLOGY FOR ASSESSMENT OF EXTERNAL COSTS OF TRANSPORT IN THE EU DOCUMENTS

External costs of transport vary considerably with the characteristics of vehicles, trains, boats, aircraft or area of transport activities. The relevant EU documents [7] cover all main externalities of transport:

- Accidents;
- Air pollution;
- Climate change;
- Noise;
- Congestion;
- Well-to-tank emissions;
- Habitat damage;
- Other external cost (soil and water pollution).

HEATCO's scientific research project [2], [3] uses an approach called "Impact Pathway Approach" based on damage cost. Using the concepts of welfare economics, monetary assessment follows the "willingness to pay" approach for valuation of the respective health effects and improving the quality of the environment. The best practice estimation of congestion costs is based on speed-flow relations, value of time and demand elasticity. The procedure for calculating external costs of transport from air pollution follows:

- Quantification of changes in the emission of pollutants (NO_x, SO₂, PM_{2.5}/PM₁₀) resulting from the project studied and expressed in tonnes, using national or European emission factors.
- Classification of emissions according to the amount of emission (near ground surface or high) and local environment (urban - out of urban areas).

- Impact calculation - years of life lost and costs per pollutant.
- Impact report and costs.

IV. METHODOLOGY FOR ASSESSMENT OF EXTERNAL COSTS OF TRANSPORT IN REPUBLIC OF NORTH MACEDONIA

Methodology for estimation of external costs of transport in Republic of North Macedonia is founded of EU researches and accepted methodology. This approach consists of the following successive stages:

1. Assessment of unit prices of external costs of transport by type of externality in a given year may be expressed as:

$$EC_{my_i} = EC_{euy_0} \cdot PPP_{my_0} \cdot A_{gdp_{y_i}} \quad (1)$$

EC_{my_i} – unit value of external cost of transport for a given externality in Republic of North Macedonia in year y_i

EC_{euy_0} – unit value of external cost of transport for a given externality estimated as EU average in year y_0

PPP_{my_0} - purchasing power parity indicator in Republic of North Macedonia in relation to the EU in year y_0 (that indicator is 100% for the EU)

$A_{gdp_{y_i}}$ - average annual growth of gross domestic product in Republic of North Macedonia between year y_0 and y_i

$$A_{gdp_{y_i}} = (1 + p)^i \quad (2)$$

p - average GDP growth rate between years y_i and y_0

i - number of years between y_i and y_0

2. Emission quantities of externalities depend on the transport operation, type of vehicles, location of transport infrastructure, and other geographical and time factors. These quantities can be expressed by the following equation:

$$Q_{my_i} = \sum Q_{my_{i,v,s}} \quad (3)$$

Q_{my_i} – total quantities for a given externality of transport in Republic of North Macedonia in year y_i

$Q_{my_{i,v,s}}$ - quantities for a given externality of transport in Republic of North Macedonia in year y_i obtained from different transport activities, different vehicles and in specific spatial conditions.

3. Total external cost of transport for a given externality can be expressed by the following equation:

$$TC_{my_i} = EC_{my_i} \cdot Q_{my_i} \quad (4)$$

TC_{my_i} - total external cost of transport for a given externality in Republic of North Macedonia in year y_i ,

EC_{my_i} – unit value of external cost of transport for a given externality in Republic of North Macedonia in year y_i ,

Q_{my_i} - quantities for a given externality of transport in Republic of North Macedonia in year y_i .

V. ASSESSMENT OF EXTERNAL COST OF TRANSPORT FROM AIR POLLUTION

The methodology presented above needs data for unit values of external costs of transport expressed as average values for EU countries. These data refer to year 2010 and they are extracted from the RICARDO-AEA study [6] on specific vehicle types, EU emission standards from Euro 0 to Euro 6 and on urban, suburban and rural environments.

The number of registered vehicles in 2015 in the country is 437 686 vehicles. The vehicle fleet is very old and the average age of cars is 18.7 years, for buses 18.1 years and for trucks 15.5 years. In 2015 half of the passenger cars and buses have EU standards with high emissions of harmful substances Euro 0, Euro 1 and Euro 2 (fig. 1, Table I).

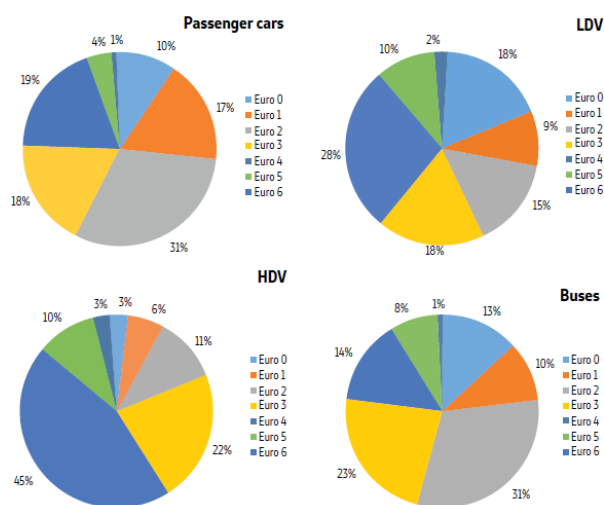


Fig. 1 Share of type of vehicles in Euro 0 to Euro 6 emission standards in 2015

TABLE I
NUMBER OF REGISTERED MOTOR VEHICLES IN 2015 AND 2018

Registered motor vehicles	Year	
	2015	2018
Total	437 686	485 612
Motorcycles	8 634	13 343
Cars	371 449	415 062
Buses	3 164	3 201
Goods vehicles	32 123	37 010
Road tractors	5 248	5 613
Tractors	8 030	2 409
Work vehicles	614	728
Trailers	8 424	8 246

Source: <http://www.stat.gov.mk/PrikaziPublikacijaIen.aspx?rbr=770>

The unit values of external transport costs are adjusted for Republic of North Macedonia using the purchasing power indicator published by Eurostat. According to this indicator (Purchasing Power Standards) Republic of North Macedonia in 2010 was 34% of the EU-28 average.

To estimate the unit values of external transport costs in a given year different of 2010 they should be weighted also by average growth rate of GDP from year 2010 to the 2015 year of analysis. The average GDP growth in the period 2010-2015 in Republic of North Macedonia is 2.54%, according to the official data published by State Statistical Office (SSO).

The estimation of emissions quantities can be made using SSO data for type of vehicle registered in the country and also data on average annual kilometres travelled by type of vehicle and the area of impact separated of urban, suburban or rural areas. Some of these data have been estimated from their own studies, and some have been obtained by processing data from SSO.

Official statistics of average annual kilometres travelled by cars on urban, suburban and rural roads and highways are not published. Since such data are not available, we made assumption that cars travel an average of 10000 km/year, of which 70% are on urban roads and 30% on suburban, rural roads and highways.

The SSO [8] Publication Transport and Other Services shows that in 2015 on average one bus travelled 79000 km. It is assumed that 70% of them are made in urban areas, 20% in suburban areas, and 10% in highways and rural areas.

The same SSO publication states that trucks in total in 2015 had 860 million kilometres. Assuming that in the same year there were 33237 registered trucks and on average in 2015 one truck travels 25875 km. It is assumed that 30% of trucks travel distances in urban areas, 20% in suburban areas, and 50% in rural areas and highways.

Concerning fuel consumption of motor vehicles, according to SSO data, the 53% of passenger cars use petrol and 47% of cars use diesel.

According to the above assumptions and described methodology, the estimations of the external transport costs of road transport from air pollution are follows:

TABLE II
ASSESSED EXTERNAL COST OF ROAD TRANSPORT FROM AIR
POLLUTION IN 2015 IN MILLION EURO

Euro St.	Cars	Buses	Trucks
Euro 0	8.1	3.9	2.2
Euro 1	4.6	1.9	3.2
Euro 2	7.2	5.1	5.1
Euro 3	3.1	3.2	8.2
Euro 4	2.4	1.2	10.4
Euro 5	0.3	0.6	1.3
Euro 6	0.1	0.0	0.1
TOTAL	25.8	15.8	30.5

The estimated external costs of road transport only from air pollution in 2015 are 72.2 million euros.

VI. COMMENTS OF ESTIMATIONS

The most important external costs of road transport from air pollution are estimated in urban areas. The external costs of transport produced by diesel cars that are in EU classes Euro 0, Euro 1, Euro 2 or manufactured until 2004 are particularly

high. The analysis of vehicle fleets shows that about 50% of passenger cars and buses have EU standards with high emissions of harmful substances. The assessment of noise pollution, using similar methodology, shows that about 64% of external transport costs of road transport from noise are appeared in urban area. Estimations of external costs of transport in EU countries plus Norway and Switzerland in 2008, account about 4% of these countries' GDP. If we apply the same percentage to Republic of North Macedonia with a GDP of 9072 million EUR in 2015, then the total external costs after this calculation is about 363 million EUR.

VII. CONCLUSIONS

The official data for transport collected by SSO are not appropriated for estimation of external costs of transport. The new methodology of data collection should be involved in the future to produce solid data for estimation of external costs of transport. The external costs of road transport are predominant in urban areas comparing with rural regions and highways. The very old vehicle fleet in the country and large presence of vehicles in Euro 0, Euro 1 and Euro 2 standards contribute significantly to air pollution. The transport policies have to provide state aid to citizens and transport operators for renewal of vehicles and usage of more environmental friendly cars, buses and trucks. The external costs of rail transport are not assessed in this paper, but the UIC estimation for 2008 [1] in the 27 EU countries notes that these cost are only 2% of total external costs of transport. Development of inter modality and favour of rail transport can also contribute to decrease external costs of transport.

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