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Evaluation of Negative Externalities Caused by Traffic

INTRODUCTION

For all of us, traffic is an everyday part of our life. Traffic has significant positive effects, but also causes a lot of negative externalities. There is traffic and health damage, environmental damage (noise, emission) and many other externalities.
The financial evaluation of negative externalities caused by traffic is an important part of the state economy. The externalities concern the loss of human life, financial and material damage, social losses funds which would be otherwise produced by this person.
We live in the modern times when a lot of values are expressed by money. People produce goods and services through their own hard work, which makes up the total value of the society.
The calculation of losses caused by traffic make up one of the factors of road safety models for calculation of the effectiveness of road safety measures. The implementation of good and effective road safety measures would be important to effectively invest funds for the elimination of negative externalities caused by traffic and for the fulfilment of the goals of the National Strategy of Road Safety. The National Strategy of Road Safety is a document of the Ministry of Transport determining goals and basic principles leading to the reduction of accidents consequences on roads in the Czech Republic. The main goal is to reduce the number of fatalities by 60% and number of serious injuries by 40% between 2009 and 2020
For this reason, it is very important to pay attention to the economic calculation of negative externalities caused by traffic and prevent later inefficient use of funds.

In the first chapter, I summarize the current situation in the Czech Republic and other countries. I mention the existing methods and approaches for the evaluations of negative externalities. In addition, I describe drawbacks of the used methodology for the calculation of losses from road traffic accidents in the Czech Republic.

The second part of the article describes our own new methodology created at the end of 2012. This new methodology does not include the identified drawbacks. I calculated losses from road traffic accidents in the Czech Republic for 2011 (according to the new and updated methodology). These outputs are showed in tables. I also show the history of costs and the impact of negatives externalities.

The last part of the article describes the recommendations for further evaluation of negative externalities, and the final conclusions.

1 CURRENT STATE

Centrum dopravního výzkumu is the only organisation performing the calculation of losses from road traffic accidents in the Czech Republic. This calculation is made according to an incomplete methodology. This methodology works with direct and indirect costs, but does not include all costs items which should be included in the calculation. The "unregistered accidents", costs of fire rescue service are not included. The calculation of all costs items (e.g. costs of healthcare) was very difficult (it was impossible to have all the data for the calculation). Moreover, there was no complete methodology for the evaluation of insurance costs. In the Czech Republic, there were changes in the legislation (e.g. payment of social costs). This methodology did not include very important subjective damage calculated to the evaluations of negative externalities in other countries.

It is possible to use the methodology "**Volkswirtschaftliche Kosten der Personenschäden im Strassenverkehr"** for the evaluation of negative externalities caused by traffic in German. This methodology is made by an organisation BAST and is also based on the method of the "human capital" (direct and indirect costs). The calculation includes other costs – human costs. Human costs include pain, psychology damage – subjective damage). Regarding the calculation, these costs recommended using the method of WTP (willingness to pay). The strength of the method is the inclusion of subjective damage in the calculation.

This issue is described in detail at the outcomes of the project HEATCO (Developing Harmonised European Approaches for Transport Costing and Project Assessment). The outcome of this project included different approaches for evaluations of negative externalities caused by traffic for selected countries, e.g. for road accidents (also using the method of "human capital"), for "unregistered accidents", environmental damage, congestions, etc. It is recommended using of the coefficient "k" for "unregistered accidents" and average material damage. The strength of this outcome is the complexity of the issues (including the evaluation of more types of externalities caused by traffic).

I created new and up-to-date methodology from the information of the current situation described above. This new methodology is described in Chapter 2.

2 NEW METHODOLOGY FOR EVALUATION OF NEGATIVE EXTERNALITIES CAUSED BY TRAFFIC IN THE CZECH REPUBLIC

The evaluation of negative externalities is possible by different approaches. These approaches vary by target and the reason for the evaluation. In Chapter one are described selected existing and using approaches for evaluation of negative externalities.
The national target of the Czech Republic is to minimize injuries and reduce road accident mortality rate. The national target is coordinated and administrated by the Ministry of Transport (key department for road safety). For this reason, the calculation and evaluation of costs caused by traffic uses the new Methodology of Calculation of Losses Caused by Road Traffic Accidents in the Czech Republic. The outputs of this methodology are used to input data for construction-technical analyses for the assessment of planned and realised road safety measures. This new methodology includes added and modified costs items (according to the experience described in Chapter 1).

This methodology is based on the method of "human capital". The method of human capital is suitable for objective evaluations of individual damage and losses. The quantification of costs and losses is made by a direct detection of health care, administration (police, courts, insurance), social costs and material damage. Concerning the evaluation of production losses, GDP per capita is used.
The statistical data are completed with expert estimates in the areas of health care, insurance, social care, traffic police, etc. The types of data are very different, e.g. macro and micro economic, demographic, operational data. These data differ further in quality, reliability and accessibility.

This calculation does not include other negative externalities caused by traffic – subjective damage and environmental pollution. For example, subjective damage include: pain, shock, loss of welfare, disruption of family and other incalculable damage. Evaluations are possible through the contingency method – WTP (Chapter 3).
Fundamental to this is the identification, quantification and subsequent evaluation of costs needed for calculation. These costs (both direct and indirect) are financial amounts determined to cover or eliminate consequences of traffic accidents.

Costs caused by traffic are divided between direct and indirect costs (Figure 1).

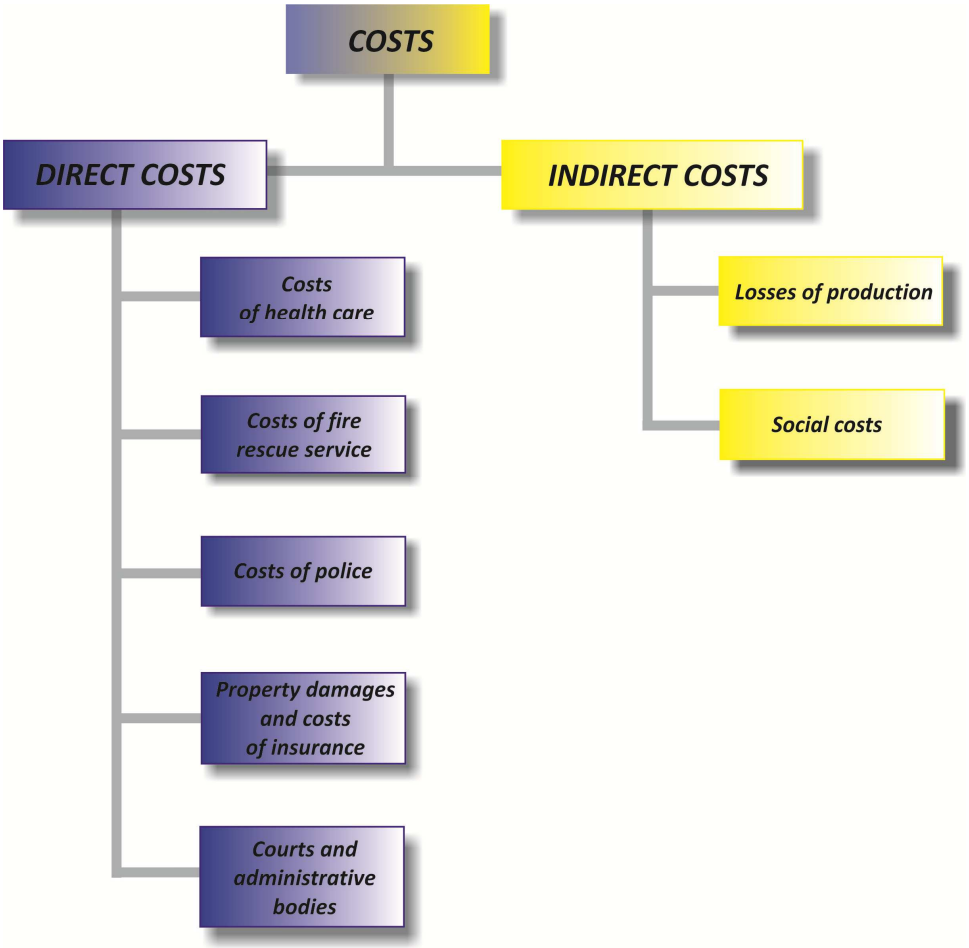


Figure 1 Scheme of costs and losses

For greater detail and also in-depth details, the calculation of losses is defined by: costs and losses divided by their impact:

- **Accidents with fatal injuries** –This research follows the international definition of "accidents with fatal injuries" which covers a period of 30 days following an accident. (In the Czech Republic an approach is currently used which only covers the first 24 hours following an accident.)

- **Accidents with serious injuries**

The difference between serious and slight injuries is based (along expression of the Police presidium of the Czech Republic) on the assessment of an operating doctor on the place of accident or later in the hospital. The operation doctor probably makes decision on the basis of MAIS scale (>3).

- **Accidents with slight injuries**

- **Material damage only accidents -** nobody is injured and only the damage of car(s) occurs.

Total costs are a product of unit costs and the number of units. Costs items are described in the following text.

A. DIRECT COSTS

Direct costs are costs that are directly related to traffic accidents and are possible to be defined and calculated in a short time. Once an accident has been analyzed, it is possible to calculate these costs. Direct costs include health care, costs of fire rescue service, police, material damage, court, insurance and administrational cost.

Costs of health care

Costs of health care are calculated in the case when an accident with injuries occurs. These costs include:

- arrival of emergency medical services to the place of accident (including transport to hospital)
- hospital care – hospitalization and rehabilitation
- autopsy (in the case of death)

Total costs of health care are a sum of these costs. These costs include:

- personal costs,
- fuel and other costs associated with medical care (medical helicopter),
- medical material (medicine),
- overheads,
- other costs.

Costs of fire rescue service

Costs of fire rescue service in the Czech Republic depend on a lot of factors. The intervention of the fire rescue service includes two parts: rescue service (medical care, treatment of injuries) and clean up works (clearing of the accident site, handling of cars, etc.)

The rescue service is funded by the budget of the fire rescue service, clearing works are funded by an insurance company. This difference is not relevant for the calculation.

Average costs for one accident are calculated from the costs of the fire rescue service in the Czech Republic where the average costs for one accident are based on the total budget of the fire rescue service divided by the number of all interventions in the year.

According to the severity of accidents, the % share of help (help on the place of accidents) of the fire rescue service is calculated. The following is a list of the costs breakdown of accidents for only the fire rescue service and the total number of accidents:

- Accidents with fatal injuries – 55 %
- Accidents with severe injuries – 90 %
- Accidents with slight injuries – 40 %
- Material damage only accidents – 8 %

Costs for each category are multiple average costs for one service and % share for accident of this category.

Police costs

Police costs include all costs associated with an accident. These costs are calculated from the time spent per accident from each category (fatal injuries, severe and slight injuries and material damage only accidents).

The examination at the location of an accident is done by two people and in the case of a very serious accident by three people, (e.g. witnesses) one person for other work. Police costs include average costs for a car (CZK/km) and average distance to the traffic accident.

Material damage and costs of insurance

The calculation of material damage is not possible to calculate only from the traffic police data (not all accidents are reported to the police – in the Czech Republic it is an obligation to report an accident with a financial amount higher than CZK 100 000).

It is very important to correct these data with the insurance figures on the total paid sum within a year. For the calculation of average material damage, the coefficient "k" is used to add the paid sum of material damage, which is much higher than material damage estimated by the police at the location of an accident:

$$k = \frac{k1 + (C1 - C2 - C3)}{C4}$$

$$k = \frac{1{,}25\ x\ (730\,216\,486 - 155\,758\,607 - 27\,520\,462)}{179\,105\,263}$$

$$\mathbf{k = 3{,}82}$$

The used data concern the year of 2011 (in EUR).

k1 – a coefficient expressing % increase of material damage and administration costs of insurance and material damage uncovered by insurance (this coefficient is 1.25 for the year 2011)

C1–paid insurance per year

C2– costs of healthcare which are paid from liability insurance

C3–costs of fire rescue service which are paid by a commercial insurance company

C4–Police estimate of the total damage

The total amount of material damage attributable to an average of individual types of accidents according to their severity is then equal to the multiple of the conversion coefficient "k" and the average amount of material damage to one accident according to police estimates.

Table 1 Total material damage per 1 injury (1 accident) in EUR

	Material damage according to police	Total number of accidents	Material damage according to police for 1 accident	**Total material damage per 1 injury (1 accident)**
Fatal injuries	5 624 740	650	8 653	33 109
Serious injuries	9 523 278	2 666	3 572	13 635
Slight injuries	49 058 974	17 170	2 857	10 907
Material damage only accidents	114 898 301	54 651	2 102	8 025

Courts and administrative bodies

Courts handle severe accidents which are classified as offences (accidents with fatal injuries, accidents with severe injuries), administrative bodies are responsible for handling minor accidents. Administration costs include personal costs, testimony, expertise costs).

B. INDIRECT COSTS

Indirect costs are not related to traffic accidents directly but they are revealed in the long term. These costs include production losses and social costs, which are describes in the following text.

Production losses

Production losses are calculated for accidents with fatal injuries and accidents with severe injuries. Production losses are the highest item in the calculation of negative externalities caused by traffic. For this reason, it is very important to pay attention to the calculation of these costs.

We need to know the following items for the calculation:

- GDP (gross domestic product) for economically active population
- average number of productive years of an average person,
- number of fatal injuries, severe injuries.

Different people have different productivity. Average values (age, sex, health and income) are used for the data accessibility and simplification of the calculation. This value is determined as a share of total GDP and the number of inhabitants in productive age.

Social costs

Social costs include:

- health insurance,
- widow's pension and widower's pension,
- orphan's pension,
- disability pension.

Social costs are calculated for each category (fatal, serious, slight injury)

3 History of costs and specific amount of costs

Losses caused by traffic are calculated every year (since 2001). The calculation is made according to the Methodology of Calculation of Losses Caused by Road Traffic Accidents in the Czech Republic. This methodology was incomplete and it was not possible to collect all data for calculation every year. For this reason, in certain years the calculation is subjected to inflation.

Total costs caused by traffic are multiple unit costs (Table 1) and number or fatal injuries, serious and slight injuries and material damage only accidents. Unit costs are defined as costs per one unit of the severity level (for example one fatally injury).

Table 2 Unit costs in EUR

Severity level	2003	2004	2004	2005	2006	2007	2008	2009	2010	2011
Fatal injury	348 839	358 011	358 011	364 822	373 916	384 404	408 591	412 268	681 231	718 742
Serious injury	110 836	120 201	120 201	122 485	125 542	129 063	137 190	138 429	148 684	185 108
Slight injury	12 964	13 506	13 506	13 777	14 125	14 512	15 402	15 557	25 193	19 690
Material damage only accidents	3 599	3 715	3 715	3 793	3 870	3 947	4 180	4 218	9 985	8 7772

Source: my own calculation

Exchange rate is 25.84 EUR/CZK (Czech National Bank, 13 May 2013).

The value of material damage is influenced by the sum of the reported damage. As of 1 January 2009 a new obligation to report accidents with a financial amount higher than CZK 100 000 (it was CZK 50 000 after 2009) was imposed. A change between 2010 and 2011 concerning the reduction of days of treatment for slight injuries was recorded. The number of accidents with fatal injuries decreased. This decrease is caused by improved health care and modern, high quality, and safer vehicles. In addition, the implementations of road safety measures and campaigns are very important.

The calculated data for direct and indirect costs (described in Chapter 2) according to the new methodology for 2011 are shown in Table 2.

Table 3: Loss per one accident according to the type of costs in 2011 (in EUR)

	Costs	Accident with			Material damage only accident
		fatal injury	serious injury	slight injury	
direct costs (EUR)	Costs of health care	7 090	52 485	1 740	0
	Costs of fire rescue service	1 689	2 764	1 228	246
	Police costs	1 873	523	340	340
	Material damage including insurance costs	33 109	13 635	10 907	8 025
	Courts and administrative bodies	371	371	161	161
	Total direct costs	**44 132**	**69 778**	**14 377**	**8 772**
indirect costs (EUR)	Production losses	667 435	98 257	4 974	0
	Social costs	7 175	17 073	339	0
	Total indirect costs	**674 610**	**115 330**	**5 313**	**0**
TOTAL loss for one accident		**718 742**	**185 108**	**19 690**	**8 772**

Source: my own calculation

Exchange rate is 25.84 EUR/CZK (Czech National Bank, 13 May 2013).

4 IMPACT OF NEGATIVE EXTERNALITIES

Losses caused by traffic are one of the negative externalities and they have an impact on the country, society and other entities. These entities are:

- state budget,
- commercial companies,
- health insurance companies,
- persons responsible for traffic accidents,
- victims of traffic accidents.

The experts from Centrum dopravního výzkumu estimate the share of each of the costs items for the above mentioned entities. Regarding the total losses caused by traffic the share of the entities is as follows: approx 41% for the state, 49% for commercial insurance companies, 5.6 % for health insurance companies, 2.6% for persons responsible for traffic accidents and 1.8% for victims of traffic accidents.

State budget

The state pays approx 41% of the costs caused by traffic accidents. These costs are paid from the state budget of these organisations:

- Ministry of Finance (Production losses),
- Ministry of the Interior (Costs of fire rescue service, administration police costs)
- Ministry of Justice (Courts and administrative bodies)
- Ministry of Labour and Social Affairs

This is amount of the loss which is charged to the state account.

Commercial insurance companies

Commercial insurance companies pay all costs of liability insurance as well as approx 50% of the costs of fire rescue service and a share on production losses.
This distribution of costs is allocated on the basis of legislative measures being in force in the Czech Republic.

Health insurance companies

Insurance companies pay costs of health care which are not covered by liability insurance. It is in the case that we do not know the person responsible for the traffic accident or it would not be possible to pay the costs from the insurance of the person liable for the accident.

5 Recommendation for addition of the evaluation of negative externalities

The methodology described in Chapter 2 does not include subjective damage. Centrum dopravního výzkumu is currently conducting research of a method of evaluation of other negative externalities caused by traffic (subjective damage). It will create a new method for the evaluation of subjective damage. This new approach will be added to the above mentioned method (Dankova et al., 2013).

One of the methodologies for the evaluation of subjective damage is called the contingency method which is used for evaluating environmental damage and the value of life. We ask the question: “Is it possible to put a value on human life?” The value of life is hardly evaluable in ethical sense; nevertheless, it is evaluable in the economic sense (life insurance).
For the evaluation of value of life it is possible to use the WTP method (willingness to pay).
The WTP method is used in the EU including the Czech Republic (although the share of using this method is not wide). This method uses a survey where people evaluate their own benefits directly, but only in a hypothetical situation.

I am currently preparing a survey for evaluating subjective damage.

It is very important to create a hypothetical market, determine a group of respondents and compile questions for the questionnaire. Respondents should be chosen according to traffic

problems covered. For example: respondents should have a driver's licence or experience with driving a car.

When creating a questionnaire, the creating of questions is very important. These questions should be easy, understandable, and short, and only yes/no answers are acceptable.

The questionnaire should be tested on a small group first, then modified and last used on all respondents. The most effective is a personal interview, especially when there is time to explain questions about the topic. Another option is to send the questionnaire by e-mail or by post.

Based on the questionnaire, the respondents give their answers about their willingness to pay. Respondents are asked a question: how much money are they willing to pay for decreasing of negative externalities caused by traffic, e.g. decreasing accidents with fatal injuries.

It is very important to distinguish WTP and WTA (willingness to accept). WTA asks respondents about the amount of compensation they are willing to accept for a negative externality.

In theory, the outputs of WTP and WTA should be comparable. But a lot of studies show that WTA is 5-6 times higher than WTP.

The WTP method also has drawbacks. WTP is a subjective method and expresses only one side of the situation. It is only a one-sided view from demand, the supply side is neglected. WTP is a combination of a distribution of incomes. WTP for inhabitants with lower income should be lower than WTP for inhabitants with higher income.

The willingness to pay is distinctly affected by the amount of income of interviewed person, which is a weakness of this method.

5 Conclusion

I created a new Methodology of Calculation of Losses Caused by Road Traffic Accidents in the Czech Republic. This calculation of economic losses caused by traffic is a basic condition for the identification, quantification and evaluation of costs caused by traffic. Traffic causes a lot of negative externalities, injuries and social damage. Just these economic losses represent 1.4 % GDP in the Czech Republic. One of the top priorities of the Czech Republic is to reduce this damage and decrease the number of accidents with fatal injuries (by the implementation of road safety measures).

The state budget has limited funds and it is very important to use these funds effectively. For this reason, it is important to pay attention to economic evaluations of negative externalities caused by traffic. The implementation of effective road safety measures should help to reduce the number and impact of traffic accidents.

It is very important to include a calculation of subjective damage also. For the evaluation of subjective damage it is possible to use the WTP method. The use of the methodology for evaluations in the Czech Republic is incomplete and does not include subjective damage. For this reason, Centrum dopravního výzkumu is preparing a new method for evaluation of

subjective damage and other costs which are not included in the current calculations. Total losses will be more accurate and will allow for the comparison with other EU states which include these externalities in their calculations.

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