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RELATIONSHIP OF TRANSPORT AND ENVIRONMENT IN THE CZECH REPUBLIC AND POSSIBILITIES OF ITS ECONOMIC EVALUATION

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1. Introduction

It is evident that transport represents an important branch of national economy. However, it brings society not only positive but also negative effects, which are the most noticeble in environmental sphere.

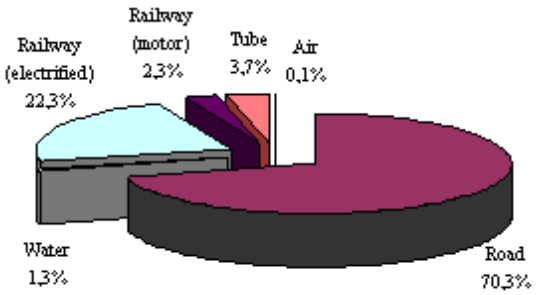
As for positive impacts, transport is a stimulator of the socio-economic development and a factor that activates the process of material production. It is also an important factor of the space economy. Transport enables the growth of inhabitants´ mobility, economic and cultural exchange among places and regions. It is necessary to emphasize the role of transport in the state defence system as well as in international exchange.

Negative transport impacts express themselves as a certain restriction or damages in various forms, e.g. on health or property, as losses in basic funds or losses following from reduction of economic activity performance or revenues, in worse conditions of housing, relaxation, recreation etc. Reduction of these negative effects on environment belongs all over the world to important tasks.

2. State and development of transport capacity in the Czech Republic

Structure of passenger and freight transport

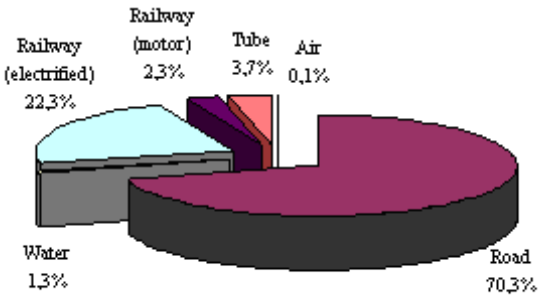
In 2005, too, individual motor transport dominated in passenger transport with 63,4 % of transport volume in the Czech Republic. A relatively good position held city public transport with s 14,8 % of transport volume. Air transport shared passenger transport with 8,9 %, road public transport (regular line buses) with 7 % and passenger railway transport with 6 %.



Source: [1]

Fig. 1 *Output of particular kinds of freight transport in millions ton-kilometres in the Czech Republic in 2005 (% of total transport output)*

In freight transport in the Czech Republic also in 2005 dominated freight road transport with 70,4 %. The second was freight railway transport with 24,6 %. The shares of tube, water and air transport were small. [1]

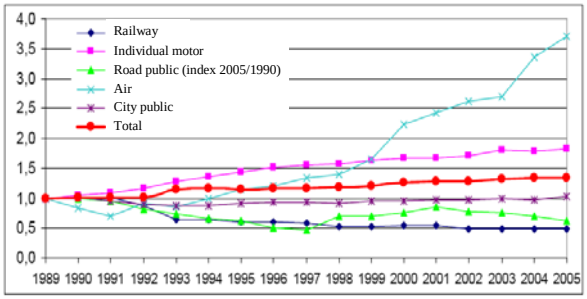


Source: [1]

Fig. 2 *Output of particular kinds of freight transport in millions ton-kilometres in the Czech Republic in 2005 (% of total transport output)*

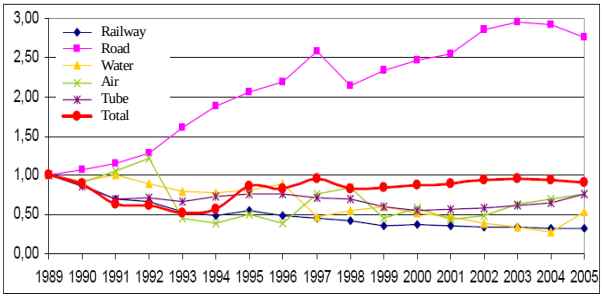
Development of passenger and freight transport volume

In 2005 as compared with 2004 in passenger transport in the Czech Republic kept fast increase of air transport volume. Volume of individual motor transport and railway transport increased moderately. The showed drop of transport by public service buses and the increase of city public transport volume is caused by the fact that about 60 smaller companies of city public transport were earlier showed as regular line buses but since 2005 as city public transport.



Source: [1]

Fig. 3 *Index of the particular kinds of passenger transport output development in the Czech Republic in 1989 - 2005 (index, 1989 = 1)*



Source: [1]

Fig. 4 *Index of the particular kinds of freight transport output development in the Czech Republic in 1989 - 2005 (index, 1989 = 1)*

Explication: In the case of railway transport it means net tariff ton-kilometres. Data of freight road transport have been calculating according to the Eurostat methodology since 1997.

It is clear from the figure 4, that changes in freight transport volume in the Czech Republic were in 2005 as compared with 2004 relatively small and considering problematic methodology of monitoring (in air, water and freight road transport is monitored output of transport companies registered in the Czech Republic together with

their output abroad but without output of foreign carriers in the territory of the Czech Republic) also hard-to-evaluate. Volume of freight road transport has been decreasing for two years. The question is if this figure is reliable because joining the EU influenced significantly international road transport, which had an impact on a considerable growth of GDP in transport sector in 2004. This trend is possible to expect also in 2005. In 2005 volume of railway and air freight transport stagnated. Surprising is the increase of freight river transport volume by a factor of almost two, but from very low initial level. [1]

3. Characterization of environmental impacts of particular kinds of transport in the Czech Republic

Railway transport

If we should summarized negative effects of railway transport on environment, we can state that:

- thanks to electric traction were reduced negative effects in the sphere of air pollution, noisiness,
- negative effects of railway traffic are spatially limited to the route vicinity and show themselves more considerably in a built-up area, especially in places of larger concentration of linear and point facilities,
- in places of more considerable activity of railway transport show themselves except for noise and emissions also vibration and shakes more perceptibly,
- from the waste point of view railway does not create serious problems,
- certain aesthetic shortcomings influencing human psychology are connected with external appearance of vehicles and their maintenance in a clear state.

Generally it is then possible to judge railway as such kind of transport that in comparison with its transport capacity gets on relatively well with its surroundings and negative effects of which is possible to further reduce considerably.

Motor transport

In the Czech Republic road and motorway system is almost six times denser in comparison with railway system. Its density reaches 0,7 km of roads of all kinds per square km in comparison with 0,12 km of railway lines per square km [1]. This space „ubiquity" of motor transport routes together with the fact that motor transport as a whole produces nearly 85 % of all transport exhalations causes that negative effects of motor transport affect overwhelming majority of population. Motor transport thus becomes the main source of the transport negative impact on environment and at the same time the main field of the struggle for its reduction.

Heavy vehicles (that means trucks and buses) are the predominant source of transport noise, first of all. Places of heavy transport concentration are thus the most exposed as for noise.

To the contrary, the main air pollutant is unambiguously individual transport. However, negative effects of exhalations show themselves only at a certain traffic concentration and are influenced by route running, surroundings of the communication and climatic conditions. Technical development gradually reduces the content of harmful substances in vehicles´ exhaust gases.

Motor transport, and first of all individual transport, has a negative impact on water pollution and land occupation. Individual transport is further the most important factor of transport accident frequency.

Environment protection against harmful effects of transport will thus concentrate on motor transport primarily.

Air transport

The characteristic feature of the air transport impact is its high share in negative effects of transport (in comparison with the share in transport capacity) – it represents about 8,5 % of all exhalations. Furthermore, permissible noise levels are exceeded in surroundings of airports. On the other hand, the real impact of particular factors affecting environment adversely is limited by:

- number of airports,
- relatively small use of these airports, except for the airport in Prague,
- location of airports mostly far enough from residential parts of cities.

As a result of it the negative impact of air transport is reduced to relatively small areas and small number of people.

Water transport

Small frequency of ships on inland waterways and good weather conditions along watercourses create conditions that we need not deal with in the sphere of noise and air pollution at all. The only one danger is diesel and other oils leakage into water.

Transport in cities

City transport includes not only means of city public transport (buses, trolleybuses, trams, underground) but also passenger cars, trucks and long-distance transport buses and passenger or goods trains, too. In relation to cities it is necessary to draw attention to the passenger cars effects as for the amount of harmful substances in air and the usage of areas for static transport.

Among means of city public transport seems the most favourably trolleybus, which offers for instance at the same noise level and the same speed four- up to eightfold higher number of seats in comparison with all other kinds of transport. Electric traction vehicles are unambiguously advantageous from the point of view of air purity. However, trams show nearly twelvefold noise equivalent in comparison with passenger car. Unfavourable effects have shakes and vibrations caused especially by run of rail vehicles including underground.

4. Economic quantification of transport impacts on environment

If we need to quantify transport impacts on environment, at first we have to define exactly spheres, in which quantification will be realized.

One of the possibilities is determination of the spheres of transport impact on environment in following way [2]:

- accidents,
- noise,
- air pollution,
- climate change
- nature and landscape,
- additional costs in urban areas,
- „up- and downstream“ processes,
- congestion.

Accidents

External costs of accidents can be determined as a sum of following, financially expressed cost items [3]:

- risk value (the aim is monetary expression of pain, sorrow and suffering caused by average accident),
- human capital losses (that means, in fact, quantification of net production loss, which can be calculated as gross production loss minus future consumption),
- medical care,
- administrative costs (police, justice, public administration etc.).

Then it is necessary to subtract from this sum various transfers following from eventual insurance benefits etc.

Noise

External costs caused by transport noise can be quantified on the basis of a sum of following cost components:

- willingness of persons affected by noise to pay for noise level reduction (this value can be best expressed as a percentage share of incomes per capita, because absolute values can not be used for international comparison – due to different level of incomes),
- evaluation of health risks following from noise (the aim is to quantify enhanced risk of civilization diseases rise in dependence of increased noise level),
- medical costs by reason of noise (critical value from the point of view of health problems rise is 65 dB; in dependence of duration and intensity of such noise level action, man can be affected by a great number of diseases as for instance high blood pressure, heart cycle complaint, cardiac infarct etc.; seeing that transport noise takes share of 8 % in the rise of heart illnesses, for example – according to the study MOSCA 2002 – it is possible to quantify costs of heart illnesses by reason of noise as follows [3]:

$$C = \frac{0{,}08 \times CHI}{NOP_{>65dB}} \tag{1}$$

where:

C ..... medical cost rate per person,

CHI ..... total economic cost of heart illness,

$NOP_{>65dB}$ ..... number of persons exposed to a noise level over 65 dB).

Air pollution

External costs connected with air pollution can be determined as a sum of following costs:

- costs connected with impacts of polluted air on human health,
- costs connected with impacts of polluted air on materials and buildings,
- costs connected with impacts of polluted air on crops and agricultural production.

Quantification of costs connected with air pollution owing to transport is based on determination of an amount of PM10 emissions, above all.

Climate change

Damages caused by greenhouse gases have global impact, no matter how and where are produced. Higher concentrations of greenhouse gases cause global warming,

which has an influence on rainfalls, frequency of hurricanes and dry periods, sea level and sea currents, with all negative impacts on human population.

An important role in greenhouse gases production is played by transport, which is the main source of CO2 emissions.

With quantification of external costs in the sphere of climatic changes is therefore necessary to focus on costs connected with CO2 emissions and their reduction.

Nature and landscape

There are several approaches how to estimate external transport costs rising in connection with nature and landscape. We can mention e.g. bio centric approach, when it is necessary to evaluate scarcity of natural environment by experts, at first. Contemporary infrastructural projects are judged even from the point of view of their environmental impact, they include enhanced costs of various compensations etc. Consequently, average costs per kilometre of new infrastructure are considerably higher than costs of older infrastructure. It is therefore necessary to calculate costs that would be required for improvement of existing infrastructure to a level that is compatible with environment needs. A set of unit costs (per 1 km of infrastructure) of environment reparation and compensations is needed for calculations, as well.

External costs for nature and landscape can be divided into following cost components:

- unsealing costs,
- restoration costs of target biotopes,
- costs of soil and water,
- costs connected with barriers formation and negative visual effects.

Measures for environment restoration and compensations have to be calculated for each of these cost components. These costs are expressed as costs per 1 m2 of landscape occupied or damaged by transport infrastructure, for example in a German study (IWW 1998) restoration costs of target biotopes are evaluated by the amount of 20 DEM/m2 (price level 1995) [3].

Additional costs in urban areas

With calculation of these costs it is necessary to consider particularly these effects [3]:

- time losses of pedestrians caused by separation effects (pedestrians must use longer route),
- space losses causing lesser possibilities of non-motor transport use in urban areas.

Further possible impacts (e.g. negative visual effects caused by increasing number of transport means travelling in urban areas and by transport infrastructure itself) are very hardly measurable and therefore unsuitable for calculations.

„Up - and downstream“ processes

In this sphere we can differentiate three important processes [2]:

- energy production itself, which is afterwards used by transport means, brings negative impacts, as well,
- transport means production and their maintenance causes further air pollution and has an influence on climatic changes,
- transport infrastructure construction and its maintenance represents further emissions and negative impacts for nature and landscape.

Although these processes has been already considered in connection with other spheres of external costs (especially with air pollution and climatic changes), it is useful to deal with them separately, namely due to an increase in transparency.

Congestion

Congestion is not classical externality because it is related only to transport users and has no impact on society as a whole. Quantification of costs connected with congestion is not trivial matter, their level can be estimated e.g. through dead weight loss, costs connected with time delay caused by congestion etc.

5. Environmental effectiveness

The basic approach to the formulation of environmental effectiveness as a component of socio-economic effectiveness represents a serious problem for the environmental effectiveness understanding.

Generally it is possible to state that the measure of effectiveness is this relation:

$$\frac{E}{N} \tag{2}$$

where:

E .....complex of effects,

N.....invested resources.

If we formulate relations among costs, effects and various management levels in the evaluation of socio-economic effectiveness on the example of passenger transport, we can divide the effects of the passenger transport development e.g. into four groups, which can be largely economically quantified [4]:

- E0 – economic benefits (receipts from transport, operating cost reduction etc.),
- E1 – benefits in technical development (advanced technology or technique expansion, founding of technical development progressive trend etc.),
- E2 – environmental benefits (lower demands on unrecoverable natural resources, less damages caused by transport noise, air pollutants, shakes etc.),
- E3 – social benefits (passengers´ time saving, improvement of employees´ working conditions, inhabitants´ satisfaction with transport quality etc.).

Accordingly we can divide also invested resources in term of their effects, where [4]:

- N0 – costs of the ensuring of passenger transport system ordinary functioning,
- N1 – costs of employees´ working environment improvement,
- N2 – costs of transport services improvement,
- N3 – costs of environment protection,
- N4 – costs connected with the founding of a progressive, prospective technical solution.

In theory, it would be possible to try to assign single effects to appropriate costs. With regard to the mentioned problems connected with costs "clearance" and their assignment to direct (planned, required) and indirect (additional) effects it is possible to draw further conclusion that socio-economic effectiveness of the passenger transport development is always necessary to judge in a complex, i.e. on the basis of the following relation [5]:

$$\frac{E_0 + E_1 + E_2 + E_3}{N_0 + N_1 + N_2 + N_3 + N_4} = \frac{\sum_0^3 E}{\sum_0^4 N} \tag{3}$$

If we install environmental elements in the formulas of economic effectiveness evaluation, the formula for the calculation of the economic effectiveness ratio that takes into account environmental damages will be following [6]:

$$E_s = \frac{I\,(r + s) + K + S}{W} = min \tag{4}$$

where:

Es .....economic effectiveness ratio that takes into account environmental damages in CZK per unit of useful effect,

I.....value of capital expenditure connected with projects realization in CZK,

r .....interest rate of capital expenditure,

s.....average depreciation rate,

K .....annual operating costs (without depreciation) in CZK,

S .....annual sum of environmental damages in CZK,

W .....amount of useful effect expressed in transferred tons or passengers, realized ton-kilometre or seat-kilometre, in trains, vehicles, airplanes etc.

It is necessary to deal with another question, too: who should judge socio-economic effectiveness and at which level. With solving this problem it will be helpful to create three levels:

- A – society as a whole,
- B – national economy as a whole,
- C – single firms.

Then we can clear also the corresponding level that meets the particular costs N0 to N4, respectively in terms of which the particular effects E0 to E3 express themselves.

Note: The article is published within the solution of the research proposal VZ-MSM 0021627505 „Transport systems theory“.

6. Conclusion

The most important position among particular kinds of transport in the Czech Republic occupies motor transport, both in passenger and freight transport. However, this kind of transport represents the biggest burden for environment, as well, which is the problem not only in the Czech Republic. Hence, it is necessary to concentrate on motor transport, first of all, with environmental transport impacts evaluation and reduction of its negative influence.

In this paper the process of quantification of transport impacts on environment is outlined in following spheres: accidents, noise, air pollution, climate change, nature and landscape, additional costs in urban areas, „up- and downstream“ processes, congestion.

As for environmental costs and effects, it is logical that the costs burden national economy, both at complex and corporate level, whereas the effects can be quantified mainly at all-society level and partly at national economy level.

Nevertheless, evaluation of transport impacts on environment is not easy at all and requires further research.

Lectored by: doc. Ing. Rastislav Isteník, PhD.

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Resumé

VZTAH DOPRAVY A ŽIVOTNÍHO PROSTŘEDÍ V ČESKÉ REPUBLICE A MOŽNOSTI JEHO EKONOMICKÉHO HODNOCENÍ

Rudolf KAMPF, Libor ŠVADLENKA, Helena BECKOVÁ

Příspěvek se zabývá problematikou vlivu dopravy na životní prostředí, a to se zaměřením na Českou republiku. Hodnotí nejprve stav a vývoj přepravní kapacity v České republice a zároveň charakterizuje dopady jednotlivých druhů dopravy na životní prostředí.

Dále se příspěvek věnuje možnostem ekonomického hodnocení vlivu dopravy na životní prostředí a definování environmentální efektivnosti.

Příspěvek je publikován v rámci výzkumného záměru „Teorie dopravních systémů“, řešeného na Dopravní fakultě Jana Pernera Univerzity Pardubice.

Summary

RELATIONSHIP OF TRANSPORT AND ENVIRONMENT IN THE CZECH REPUBLIC AND POSSIBILITIES OF ITS ECONOMIC EVALUATION

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The paper deals with the problems of transport impacts on environment, namely with a view to the Czech Republic. At first, it evaluates state and development of transport capacity in the Czech Republic and characterizes impacts of particular kinds of transport on environment, as well.

Furthermore the paper attends to possibilities of economic evaluation of transport impact on environment and definition of environmental effectiveness.

The article is published within the research proposal „Transport systems theory“, which is being solved at Jan Perner Transport Faculty of the University of Pardubice.

Zusammenfassung

DIE BEZIEHUNG DES TRANSPORTES UND DER UMWELT IN DER TSCHECHISCHEN REPUBLIK UND MÖGLICHKEITEN IHRER ÖKONOMISCHEN AUSWERTUNG

Rudolf KAMPF, Libor ŠVADLENKA, Helena BECKOVÁ

Der Beitrag befasst sich mit der Problematik der Transportwirkung an die Umwelt, und zwar mit der Orientation auf die Tschechische Republik. Zuerst wertet er den Stand und die Entwicklung der Transportkapazität in der Tschechischen Republik und zugleich charakterisiert er die Effekte der einzelnen Transporsorten an die Umwelt.

Der Beitrag ist weiter den Möglichkeiten der ökonomischen Auswertung der Transportwirkung an die Umwelt und der Definition der Umwelteffektivität gewidmet.

Der Beitrag ist im Rahmen der Forschungsprojekt „Theorie der Transportsystemen“ an der Fakultät für Transportwesen an der Univerzität Pardubice publiziert.