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Transport and Health Risks of Transport

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ABSTRACT: The increasing amount of gases and solid pollutants emitted into the atmosphere have a considerable impact on human health and environmental ecosystems. Specifically, long exposure to high concentrations of pollutants may lead to a shortening of life by several years due to cardiovascular and respiratory diseases, and contributes to increased risk of death. Recent studies also indicate cancer occurrences related to some pollutants, namely PM, that are hazardous not only due to their physical parameters, but mainly due to their content of many dangerous organic compounds, such as hydrocarbons, polyaromatic hydrocarbons and their derivates, and inorganic compounds, such as Pb, Pt, Cd, As, Cu, Zn, and others, nitrates, ammonia ions, sulphates, etc.

KEY WORDS: transport, health, emissions, noise, inactivity, accidents.

1 INTRODUCTION

The most serious issue for traffic is air pollution through emissions, due to their health and environmental risks. This negative phenomenon is evident in large cities with high traffic volumes, where, especially in recent years, a considerable increase has been recorded and the increased share on health risks was connected with the exposure of people to these pollutants. Other modes of transport, apart from car transport, contribute to air pollution as well, such as railway, air, and water transport. The electrified railways need energy which is mainly produced in power plants burning fossil fuels. But the chemical emissions produced by the combustion and non-combustion processes are not the only factors seriously threatening human health. The acoustic emissions (noise), vibrations, accident rate, or inactivity are also very serious problems. The following chapter gives a brief but complex overview of the negative traffic effects in terms of possible health risks.

2 CHEMICAL EMISSIONS

2.1 Emissions from combustion processes

The composition and size of emissions depends mainly on traffic volume, quantity and composition of fuels, type and condition of engines, and the way of driving. It is estimated that the weight unit of emissions from motorised traffic in cities and large residential areas is ten times bigger compared to emissions produced by other sources (industry, heating) and even a hundred times bigger when compared to emissions in rural areas. The exhaust gases of motor vehicles contain hundreds of chemical compounds

in various concentrations with different effects on human health. Apart from the "classic" monitored pollutants, e.g. nitrogen oxides (NO_x), carbon monoxide (CO), carbon dioxide (CO_2), and sulphur dioxide (SO_2), attention has recently been paid to persistent organic pollutants such as polyaromatic hydrocarbons (PAH), polychlorinated dibenzodioxines (PCDF), or polychrorinated dibenzofurans (PCDF). The area which is currently being carefully monitored, as a consequence of increasing concentrations in the environment, is the particulate matter (PM), mainly their smaller fractions, whose major source is road transport. The danger of these particles does not lie only in their mechanical properties, but especially in the high-risk content of organic or inorganic pollutants (Adamec, 2005). Long-term exposure to PM effects shortens life expectancy due to cardiac and lung diseases; changes in the immune system of people are not negligible either (Bencko et al., 2006).

Whereas the biological effects and health risks of gas pollutants (e.g. NO_x, CO, SO_2) are based on their seriousness (i.e. a dose – response) and a rather simple determination of the expository concentrations is well-defined, the application of this approach is not the most suitable for PM, because the same concentration of particles at two different localities does not have to represent the same risk when considering the often very different chemical composition of the pollutants which are bound to them. In addition to the concentration of total suspended particles (TSP), particles smaller than 10 micrometers (PM_{10}) or soot, the issue of individual sizing fractions representation, mainly $PM_{2.5}$, $PM_{1.0}$ and composition determination has become more monitored in the world. Furthermore, findings from the last few years have shown that also concentrations lower than the set limits can damage human health, particularly over long exposure. Therefore, this group is not nowadays perceived as an inert mass of particles which could clog up the lungs and cause damage to the organism, but as a heterogeneous mixture of particles with various physical and chemical properties (Mauderly, 1999, Morawska et al., 1999) which depend on the source and the mechanism of the particles creation, and predisposes their biological effects (Ball et al., 1987, Sagai, 1993, Dockery, Pope III, 1994, Schwartz, 1994, Vedal, 1997).

PM content in the atmosphere increased during 1990 – 2001 by 12% (THE PEP, 2004). A range of studies have shown in their conclusions the definite connection between air pollution by PM and the occurrence of respiratory diseases and asthma, which could lead, according to a study by WHO (THE PEP, 2004), to the death of children under the age of 5. The most endangered group is particularly inhabitants who live in the proximity of a road with high traffic volume. The possible consequence of the increased PM concentrations in the air is the increase in the number of deaths as a consequence of chronic bronchitis which is the fifth largest cause of global mortality. Some studies even point to the possible risk of respiratory organs cancer (THE PEP, 2004). Provo University in Utah (USA) has carried out very detailed research (Dockery, Pope III, 1994) whose results are alarming. For the period of 16 years scientists monitored 500 000 people living in big cities with a high concentration of fine dust. 22% of people died during the period, out of which almost half died as a consequence of cardiac arrest. The study states that the increased content of particulate matter of 10 $\mu g.m^{-3}$ demonstrably caused the increase of cardiac diseases by 12% and by 18% of ischemic diseases which could even lead to a heart attack. According to other sources, a 40% increase of lung cancer in the long-term exposure to high concentrations of the exhaust gases of diesel engines (Dora, Phillips (eds.), 2000), has been observed as well. A detailed study on the impacts of air pollution on population health was carried out in eight largest cities in Italy where average PM_{10} concentrations between 1998 and 1999 higher than 45 $\mu g.m^{-3}$ were discovered, where, by a content reduction to 40 $\mu g.m^{-3}$ 2000 people could have been prevented from dying (Martuzzi et al., 2002). Expert sources state that 200 people die in London every year as a consequence of air pollution from traffic, the same number have to be hospitalized, further 1000 require regular medical care

and 500 000 – 1 000 000 people require a minor medical examination. APHEIS (Air Pollution and Health: a European Information System) states that the reduction of PM_{10} of 5 $\mu g.m^{-3}$ level may prevent 1560 people from possible death. If the PM_{10} level declines to 20 $\mu g.m^{-3}$ the presumed number of dead people could be even reduced by 11 855 (THE PEP, 2004). Switzerland, France, and Austria were dealing with a joint project on the impact of air pollution on citizens in the late 1990s. The number of dead people connected to air pollution in these countries was approximately 40 000 in 1996, whereas about half of them were a consequence of pollution stemming directly from traffic. Primarily, people with weakened immune systems, asthmatics, cardiac patients, and children who inhale the exhaust gases almost "directly" from the exhaust pipes, are under threat. Emission production is linked to almost 135 000 asthma attacks and 300 000 attacks of bronchitis among children under 15, compared to 25 000 attacks of bronchitis for adults over 25. According to various sources (Filliger et al., 1999, Dora, Phillips (eds.), 2000), up to 102 000 – 368 000 people die annually in Europe as a consequence of air pollution, out of which 36 000 – 129 000 deaths could be perceived as a consequence of long-term exposure to traffic pollution in European cities. Approximately 35% of those dead people could be connected directly to pollution caused by particulate matter (Filliger et al., 1999). According to the latest research carried out by the European Union (EU), 310 000 people die annually in the whole EU of diseases connected with air pollution; and fine dust decreases the life expectancy of each European by nine months on average. Only in Germany this means 65 000 deaths a year (Watkiss et al., 2005). Air pollution is responsible for claiming approximately seven times more lives than traffic accidents on European roads, through which "only" approximately 45 thousand people die every year. PM possible entrance to the human body depending on their size is shown in Figure 1.

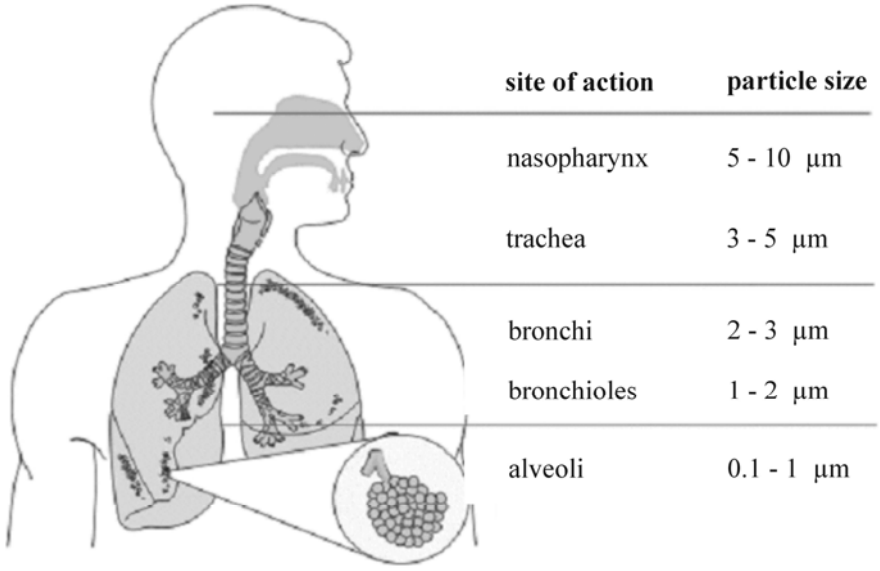

Figure 1: Distribution of particulate matter (PM) in the respiratory system (Dora, Phillips (eds.), 2000).

The recent interest in this issue and search for the solution in the Czech Republic is reflected in the fact that on the basis of the air quality evaluation more than 25%

of the Czech population live in areas where the limits for PM_{10} are exceeded (Fiala, Horálek, 2003).

Not negligible amount of PM in the air also comes from regional and long-distance transport, which could influence the concentration of these particles and distort the share of traffic in the total pollution (Tiita et al., 2002). That is the reason why it is necessary to study thoroughly the physical and chemical properties of the particles which are emitted from traffic and the methods of their identification.

According to the EU directive valid in all member states, the content of fine dust in the air, particles of a diameter up to 10 μm (PM_{10}), may only exceed the maximum limit of 50 $\mu g.m^{-3}$ on 35 days a year, whereas an annual average limit is determined by 40 $\mu g.m^{-3}$ (Act No. 86/2002, Sb.). Considering the deteriorating air quality, the EU produced a study defining the contaminated regions as those where the limit figures are exceeded more often than is permitted (Watkiss et al., 2005). Among those there are some areas of the Czech Republic, such as Prague, Brno, Ústí nad Labem, Karviná, and Ostrava, where exceeding concentrations of air-borne dust occurs more than a hundred times a year. The mentioned limit values are being exceeded during the first three months of the year. A similar situation happens in some European areas as well.

The above mentioned mainly concerns the particles with a diameter up to 10 μm, whose contents have been monitored regularly in the Czech Republic since 2002 on the basis of the Air Protection Act (Act No. 86/2002, Sb.). Currently, the extension of monitoring and pollutant limit concentrations for finer particles with a diameter under 2.5 μm ($PM_{2.5}$) in the legislation are considered, because they go through respiratory tracks to the lungs, where they accumulate, and, therefore, they are far more dangerous than the previously observed PM_{10} (THE PEP, 2004).

The knowledge about harmful effects derived from a huge amount of epidemiological and toxicological studies about the overall human exposure to these particles have started these activities with the aim to reduce the concentrations of particles in the air (Schwartz, 1994, THE PEP, 2004, Krzyzanowsky et al., 2005).

Among other pollutants which negatively influence human health and originate from traffic are PAH, which is a group of organic compounds occurring during the imperfect combustion of fossil fuels. The exhaust gasses of diesel engines contain lower concentrations of some gas emissions (NO_2, SO_2), but, on the other hand, produce higher PM concentrations, to which a whole range of pollutants are bound, the most serious being PAH. Those are absorbed in the lungs and digestive tract and metabolized by the poly-functional oxidase system. Many of them are mutagenic and carcinogenic. A study carried out among diesel traction workers of American railways showed that workers under the age of 65, who have been exposed in the last 20 years, had a small, but nevertheless, statistically considerable, increase in the risk of lung cancer. Other studies among workers exposed to car emissions indicate that men employed as truck drivers had a statistically significant 50% increase in the risk of bladder cancer. On the basis of the results, focused on benzo(a)pyrene (BaP) as a reference substance from the PAH group, it is estimated that the upper limit of the lifelong risk of cancer is around 62 cases per 100 000 exposed people per μg of benzene of the dissolved coal emissions, dispersed in m3 of the surrounding air. A 0.71% content of BaP is expected in these emissions. The risk of cancer occurrence for people exposed to 1 mg BaP per m^3 during their whole life is estimated to be 9 cases per 100 000 people (Šuta, Bencko, 1998).

A very important group of substances associated with traffic emissions is nitrated polyaromatic hydrocarbons (nPAH). However, the occurrence of these substances is predominantly connected with diesel combustion in diesel engines and with chemical reactions among PAH bound to particles (fluoranthene, pyrene and benzo(a)pyrene)

or in the air (naphthalene, phenanthrene) and NO_x, when both reactant groups are emitted by traffic.

The widespread introduction of unleaded fuels led to significant changes in the fuel composition in the effort to maintain sufficiently high octane rating of fuel. The octane rating of fuel is used for the expression of anti-knock properties, by comparing these properties with the reference fuel containing iso-octane. Then the percentage of iso-octane content is the octane number of fuel. In engine construction various octane numbers are used depending on the operational conditions. RON (research octane number) is important for medium speed and engine load and MON (motor octane number) for high speed and engine load. These critical values are critical for proper vehicle operation and all European fuels have to reach certain conditions for RON and MON. Olefins produced by the alkylation process in combustion having good RON, but low MON, are undoubtedly the main class of fuel substances, which leads to an occurrence of 1.3- butadiene in burnt gases. It is classified as a carcinogen, causing leukemia, and it is especially important for photochemical reactions in the atmosphere, which contribute to the occurrence of photochemical smog. The relation between olefin content in the fuel and the production of volatile organic compounds (VOC), mainly 1,3- butadiene, was demonstrated clearly in the studies (Šuta, Bencko, 1998) in which fuels with various composition were tested. The fuels with a content of arenes (aromatic hydrocarbons) fluctuating between 20 and 57% and olefins between 0.5 and 33%, are typically used in the EU. The measurement results showed the dependence of benzene emissions on the original content of these hydrocarbons in fuel. An important fact is that benzene content in all fuels is approximately constant and it shows that its larger amount in the burnt gases comes from the conversions of other aromatic fuel components. The high concentrations of arenes in unleaded petrol could enhance the benzene quantity in the external environment by even 50%, and considerably influence benzene concentrations even in the indoor environment of buildings.

Table 1: Overview of exposure to selected pollutants of individual modes of transport (Kingham et al., 1998).

Pollutant	Transport	Mean value	Standard deviation	Min	Max
Benzene ($\mu g.\ m^{-3}$)	Car	108.3	106.2	15.3	265.5
	Train	12.9	10.3	4.2	30.0
	Bus	21.2	18.2	5.9	53.9
	Bicycle – road	26.5	25.9	5.5	74.6
	Bicycle – field path	15.7	17.5	4.8	50.7
Absorbed PM ($\mu g.\ m^{-3}$)	Car	7.6	4.4	3.5	14.7
	Train	5.7	2.0	3.5	7.7
	Bus	5.3	3.0	2.3	10.7
	Bicycle – road	6.3	4.6	2.9	15.1
	Bicycle – field path	2.7	2.0	1.2	6.7

Other VOCs (ethylbenzene, toluene, o-, m-, p-xylene) have been discovered in emissions, in relation to initial arene content in the fuel. Approximately four times more toluene was emitted when using unleaded petrol in comparison with leaded fuel with low arene content.

The results of these studies support the opinion that the cars using petrol with olefin and arene concentration increase the occurrence of benzene, 1,3- butadiene and other VOCs in the air and thereby they increase the risk of potential diseases, such as leukemia (Šuta, Bencko, 1998).

Table 2 provides a brief overview of selected pollutants produced by traffic which contaminate the air, and their occurrence and health risks.

Table 2: Sources and characteristics of air pollutants from traffic (Adamec et al., 2005).

Pollutant	Health risks
Carbon dioxide (CO_2)	It is irrespirable. A human withstands 1.5% concentration in the air during a period of several hours without any consequences. Higher concentrations are more dangerous: for example concentration of 3 – 5% is life threatening after half an hour, 8 – 10 % causes a rapid loss of consciousness and death.
Carbon monoxide (CO)	It stops the oxidation of blood in the lungs (creation of carboxyhaemoglobine), heart, brain disorders, visual and hearing problems, digestion problems, and abdominal pains. In the case of serious poisoning unconsciousness occurs. Death by suffocation is caused by concentrations over 750 $mg.m^{-3}$.
Sulphur dioxide (SO_2)	Toxic gas with irritation effects, causing breath problems, changes of lung capacity and lung functions.
Nitrogen oxides (NO_x)	Irritation effects, mild to serious bronchitis or pneumonia, even acute pulmonary oedema.
Nitrous oxide (N_2O)	No real breath phase-out and heart problems; although possible unconsciousness and consequent suffocation. Long term exposure can cause vitamin B_{12} deficiency nerve damage and blood cells production disorder, decrease of psychomotoric function, cognitive function, memory failures.
Ozone (O_3)	Exposition to O_3 causes cellular and structural changes, whereas the general influence lies in lowered lung capability to execute normal functions.
Lead (Pb)*	Toxic metal, poisoning (chronic) shows loss of appetite, slackness, headaches and artrodynia, stomach and intestine problems, cramps in abdomen, damage of liver and periphery, or central nerves.
Cadmium (Cd)	Toxic metal.
Nickel (Ni)	Toxic metal.
Chrome (Cr)	Toxic metal, mainly as hexahydric compounds.
Platinum metals (Pt, Rh, Pd)	Toxic metals.
Polycyclic aromatic hydrocarbons (PAH)	Many compounds from this group have demonstrable mutagenic and carcinogenic effects (benzopyrene, nitro PAH).
Methyl-terc.-butyl ether (MTBE)	MTBE is of low acute inhaling toxicity, middle acute toxicity in its usage, it is not genotoxic, but in high concentrations it can induce the occurrence of tumours in rodents´ bodies. Information about long-term, reproductive, and carcinogenic effects on human is currently not available.
Volatile organic compounds (VOC)	The risk connected with exposure to VOC could be divided into four main categories: acute irritating effects, carcinogenicity, neuro-behavioural influences, hepatotoxic and nephrotoxic affection. VOC could, in higher concentrations, cause the acute irritation of eye conjunctivas and respiratory tract, headaches, dizziness, faints, overall feeling of slackness, uneasiness. These effects are reversible, they disappear if exposure is terminated or radically reduced. The synergy between the individual components of VOC could emphasize the impact on health of some compounds from a wide spectre of VOC.

Pollutant	Health risks
Benzene	The damage of nervous system, liver, immunity, airways, leukaemia. The human carcinogen classified in the group 1 (i.e. Carcinogen compounds for human) IARC is shown, classified to group A according to US EPA. It is not possible for it to determine the safe limit in the air as well as for genotoxic carcinogen.
Toluene	Inhaling experiments on animals shown that the majority of toluene is distributed to fat tissue, adrenal glands, renal and brain. Serious dysfunctions of CNS and damage of chromosomes of the periphery lymphocytes have been discovered.
Styrene	Toxic effects of styrene on the human organism consist of disorders of CNS function (headaches, slackness, tension, uneasiness, vomiting) and with exposure to high concentrations (over 420 mg. m3) the acute irritation of the ocular conjunctiva and mucous of upper parts of the respiratory tract, increase of chromosomal aberrations in the periphery lymphocytes have been observed.
Formaldehyde	Breathing disorders, irritable effects of the mucous (nose, eyes), asthma, skin allergy, leuaemia.
1,3- butadiene	In low concentrations it could cause the irritation of eyes, nose and neck. The acute effects in high concentrations could lead to damage of the central nervous system, headaches, decrease of blood pressure or even unconsciousness. It is a compound classified as carcinogen suspicious of leukemia developing (group 2A IARC), according to US EPA as a probable human carcinogen of B2 group.
Particulate matter (PM)	The seriousness depends on their size, form, and the properties of the pollutants which are bound to these particles (for example heavy metals, PAH). Short-term exposure is characteristic by breathing problems and worsening of health conditions, mainly of asthmatics, so the long-term exposure leads to respiratory and cardiovascular diseases, which lead to the decrease in life expectancy as well. Some studies show connection with the occurrence of carcinogen diseases (lung cancer).

* *Although Pb (tetramethyl-lead) has not been a part of fuels since 2001, its content in the environment in connection with human activity is still apparent.*

2.2 Emissions from non-combustion processes

Although a substantial part of pollution comes from combustion processes, the key share of emissions from traffic comes the non-combustion emissions. Whereas combustion emissions are reduced with the vehicle fleet renewal, the non-combustion emissions remain on the same level and in the foreseeable future will increase with the increasing traffic volumes. All these particles, due to their size, settle quickly on the road surface and in the vicinity of their sources. They get back into the air by re-suspension as a consequence of turbulent air circulation, initiated either by passing cars or by wind blow. The negative effects of these emissions are, similarly to combustion emissions, dependent mainly on their physical and chemical properties.

3 ACOUSTIC EMISSIONS

3.1 Noise emissions

An integral part of the human environment is the noise environment. Noise is generally understood as a sound or sounds which are undesirable, disturbing, or harmful to people. An excessive occurrence is, like air pollution, one of the most serious factors which negatively influence the population's health condition and triggers a range of undesirable reactions in the human organism. The same standard affects individual types of people differently, according to given circumstances. However, it is proven that each noise, after a certain period, triggers disorders of the higher nervous system which not only leads to hearing damage, but to damage of other body organs as well, and reduce the organism's

endurance to external negative effects and supports the development of other diseases. The modern period, mainly with the development of traffic and industry, has brought a huge amount of new sources, among which we may identify objects produced by humans (mainly means of transport, such as cars, trams, underground, airplanes), partially the humans themselves (e.g. in the classroom), as well as the natural sources (storms). The sources in the human environment and their classification are shown in the following Figure.

Road transport has become the dominant source of noise in the external environment. Rail and air transport considerably affect, through their negative effects, a smaller number of population than road transport, however, their intensity is more severe mainly at night. Among the main sources of noise there are engines at low speeds of vehicles; noise from tyres rolling on the road surface is the source of noise at higher speeds. Current research shows that approximately 60% of the amount of the overall noise burden of the population is responsible for the burden in the non-work environment, which means 70-85% of noise coming from road traffic. A lot of environmental factors, such as air temperature and humidity, its circulation, and the surface quality of objects produce noise in the environment.

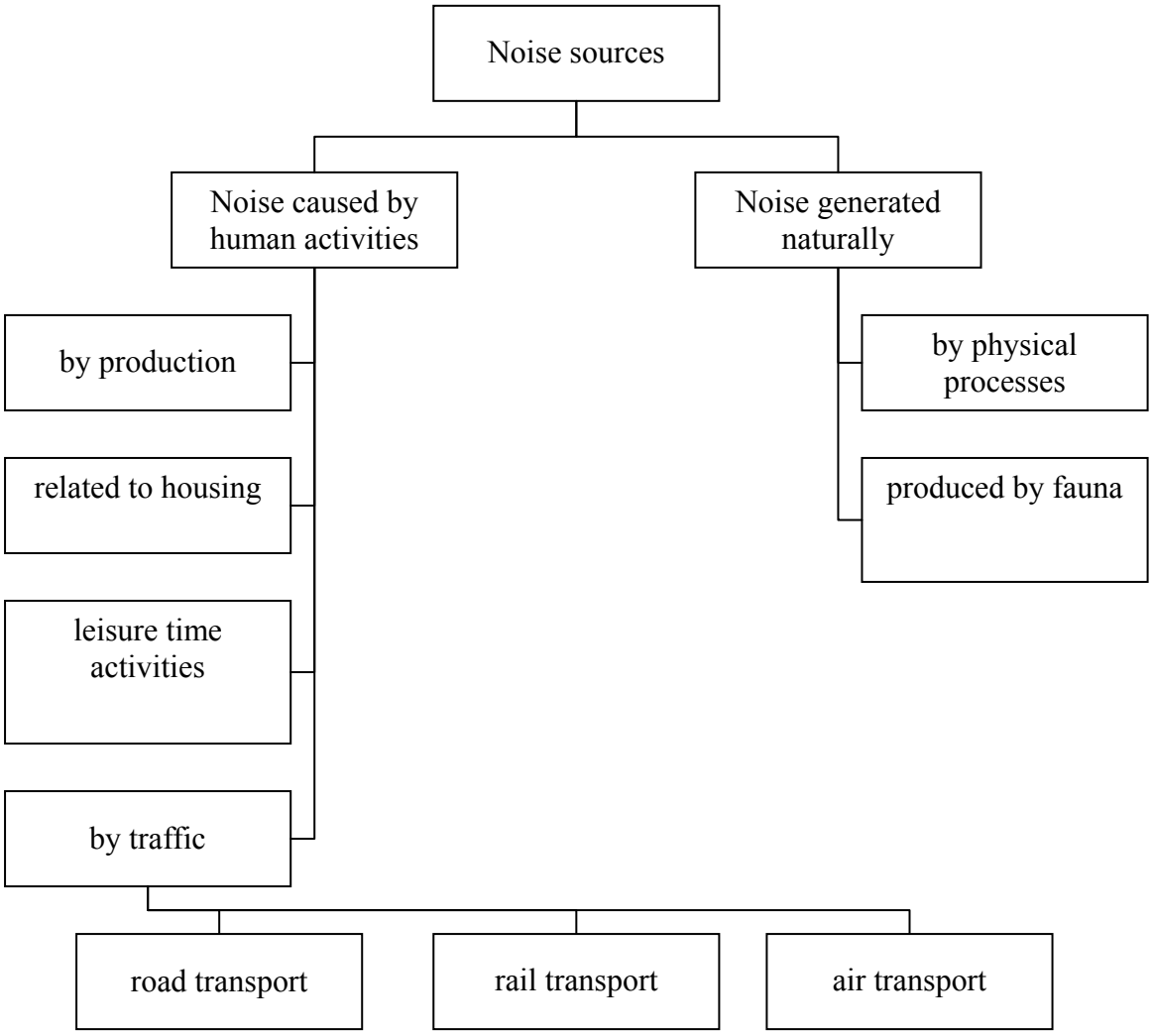

Figure 2: The sources of noise in the environment.

Traffic noise usually does not represent a significant risk for the direct damage of hearing. More serious is the unspecific (unheard) or the so-called systemic noise The influence on the condition of human health under the impact of excessive noise will be represented by cumulating many factors even over a longer period, presumably 10 - 15 years. A long-term stay in a noisy environment causes a range of unspecific disorders which are reflected both in the mental, and, secondarily, in the physical condition. This covers mainly impaired concentration and learning ability, fatigue, sleeping disorders, aggravation of child language adoption, and adversely affects a range of physiological processes and nerve functions.

The closest relationship between prolonged exposure to noise and health conditions was demonstrated for cardiovascular diseases. Other diseases which may appear due to a prolonged exposure are diabetes, gastric ulcer and ulcerous duodenum, tumors, catarrhs of the respiratory upper tracks, gallstones and calculus in the bladder, etc. (Havránek et al., 1998).

The perception and evaluation of individual sounds made by people is different. It depends on the individual´s sensitivity, functional condition of hearing, but mainly on the noise characteristics. Generally, the individual noise impulses (e.g. passing of trams) are more easier to accept for humans than long-term steady noises (noisy streets under the window); harmonic sounds are also mostly perceived as more pleasant. The human ear is able to perceive sounds of the frequency range of approximately 16 Hz up to 20 000 Hz. The upper limit of the frequency extent of audibility decreases with age. The sound has to have a higher intensity than the minimum sound intensity which is able to evoke the auditory perception, the so-called threshold of audibility, in order for the sound to be audible. A sound pressure level higher than 110 dB causes an unpleasant sound perception which is sometimes called the threshold of feeling. In the case of such sound levels, completely deaf people can also feel the tactile sensation. On even higher levels we find the threshold of pain which is accompanied by a risk of irrevocable hearing damage. The overview of subjective feelings is presented in the following Table 3.

Table 3: Sources of noise in the human environment (Vaverka et al., 1998, Berglund et al., 1999, TR, 2007).

Example of noise source	The level of sound L_A in dB	Example of noise source	The level of sound L_A in dB
Threshold of hearing	0	River weir	70
Rustling of leaves	10	Passenger car (7 m)	80
Snow-capped forest	20	Tram (60 km. h-1)	90
Room in the flat at night	30	Symphony orchestra	100
Night silence in open land	40	Horn of the locomotive	110
Pedestrians walking at night	50	Start of military jet aircraft	120
Common conversation	60	Threshold of pain	130

As has already been mentioned, the perception of noise is a subjective feeling which differs for each individual. Differentiated terms for the characterization of subjective effects on humans have been introduced. The terms are as follows:

- disturbance in which sound interferes with some activity (sleep, intellectual work, verbal communication, etc.),
- nuisance and feeling of discomfort resulting from noise exposure and noise experienced negatively by person or group concerned,

- noise level which is a subjective evaluation of a feeling of a noise unsuitable in a specific environment,
- annoyance, which represents an unacceptable impact of the environment, or group or personal rights (Miedema, 2001, Havránek et al., 1998).

The conclusions from the assessment of the noise consequences from road transport for the life quality of the population are supported by a range of presented information on the monitoring of health and the environment within the Systemic monitoring of the population health conditions in relation to the environment. The estimates of the health risks of noise comes from the relation between the noise burden and the health indicators of the exposed population. Information on the respondents' health conditions is given in correlation with studied levels of noise recorded at corresponding localities. The current economic estimates of annual damage in the EU from environmental noise influences range from €13 to €38 billion. The elements which the estimates took into account are reductions of real estate prices, medical expenses, decreased possibility for land use, and expenses caused by disability. In spite of some uncertainties, that the estimates rate the losses in € tens of billions a year (OECD, 1995).

According to the World Health Organization - WHO, around 40% of the population in the EU is affected by noise from road traffic with an equivalent level of acoustic noise pressure which exceeds 55 dB (A) during daytime, and 20% of the population are affected by levels exceeding 65 dB (A). The letter A marks the used weight filter in which the course of filtration corresponds with the frequency dependence of human hearing. If we take into account all sources of noise, then approximately one half of EU citizens live in areas which are unfavourable to a quality life. It is further estimated that more than 30% of the population are exposed to an equivalent level of acoustic pressure exceeding 55 dB (A) at night and they are disturbed during their sleep (Berglund et al., 1999).

The statistically assumed growth of selected groups of risks caused by the noise, expressed for five-decibel zones of steady exposure to night noise, is mentioned in Table 4. The prediction of an increased percentage of affected people comes from the statistical evaluation of the frequency of health problems in relation to night noise exposure L_{Aeq} 22-6 h for an average exposed person living in a Czech town or city. The results are mentioned in the final reports on monitoring the population's health conditions in relation to the environment, which has been in executed in the Czech Republic in a long-term. The zone 35 – 40 dB is considered to be a noise exposure in which there is no increase in the frequency of troubles and diseases. Thus the initial values actually indicate the incidence applicable in the population without the noise exposure (ZÚ Brno, 2006).

Table 4: Relative increase of problems due to exposure to traffic noise levels at night (ZÚ Brno, 2006).

The effects of long-term exposure to external traffic noise– night (L_{Aeq}, 22-6 h)						
Unfavourable effect	**dB(A)**					
	35-40	**40-45**	**45- 50**	**50 - 55**	**55 - 60**	**60 - 65**
Percentage of people with heart attack	Up to3.7	3.7 - 4.1	4.1 - 4.5	4.5 - 4.9	4.9 - 5.4	5.4 - 6
Percentage of people with disturbed sleep	Less than 11	11 - 12.5	12.5- 13.8	13.8 - 15	15 - 16.5	16.5 - 18.5
Percentage of people using tranquilizers daily	Less than 3.5	3.5 - 4	4 - 4.5	4.5 - 5	5 - 5.7	5.7 - 6.5

Excessive noise level in the surroundings of the roads is one of factors which are brought by the development of traffic and its seriousness is rising steadily. The hygienic imission limits of noise and vibrations at workplaces, in residential buildings, public facilities and buildings, in open spaces; and the method for their measurement and evaluation are set in the Government Regulation No. 148/2006, Sb., on health protection against the unfavourable effects of noise and vibration. The value of noise in open spaces is expressed by the equivalent level of acoustic pressure A $L_{aeq,T}$. The highest acceptable equivalent level of acoustic pressure A in open spaces (with the exception of noise from air traffic operations) is set by adding a basic noise level of 50 dB to the appropriate corrections for daytime or night time period and place in accordance with the appendix of this regulation.

"Amendment to the Methodology for Calculating Noise from Road Traffic" is the used computing method for the calculation of noise from road traffic in the Czech Republic. However, it is not mandatory by the legislation. The amendment also contains the methodology for noise measurement of the road traffic. This methodological document has a status of computational method for the calculations of acoustic situation conditions in the outdoor environment for the purposes of hygienic assessment. Currently, there is a second edition available of "Amendment to the Methodology for Calculating Noise from Road Traffic" from 2004. The last, and in terms of development, the highest degree of systemic models for the evaluation of the impact of traffic on acoustic situation in the outdoor environment is "Guidelines for the calculation of traffic noise levels" from 1991, which contains the calculation methods for noise calculation from road, railway, tram, and trolley-bus traffic, and from traffic in parking areas.

The graphical form of the acoustic calculations results is the acoustic map. The software form of the Czech calculation methodology is a HLUK+ software, furthermore, a whole range of foreign computing software is available, e.g. SoundPLAN, LIMA, MITHRA, CADNA, IMMI, etc., which usually provide the user with the possibility to choose from many implemented computing methods. These programmes allow the users to create a 3-D model of an area in question and perform a calculation of noise levels to find out the number of people affected by the noise.

To secure the effective system of noise evaluation and management in the environment, the Directive of the European Parliament and Council 2002/49/EC from 25 June 2002 was adopted, whose goal is to define a common approach to avoidance, prevention, and reduction of harmful noise effects on human health, and to provide public with information on the environmental noise and its effects. This Directive was implemented in the Czech legislation by Act No. 222/2006, Sb., which superseded Act No. 76/2002, Sb., on the integrated prevention and pollution limits, on an integrated pollution register, and on changes in some Acts (Act on integrated prevention), as amended, and Decree No. 523/2006, Sb., which sets the limit values of noise indicators, their calculation, basic content demands of strategic noise maps, and action plans, and conditions for public participation in their preparation (Decree on noise mapping).

According to the above-mentioned Directive No. 2002/49/ES, the noise maps (number of people, respectively residences, exposed to noise) in the surroundings of main roads, railway lines, airports, and in the agglomerations, will map the noise level affecting the population. The first stage of their production finished in 2007, in the next five years further noise maps will be processed according to the Directive and a revision will be made, eventually updating the processed maps for the surroundings of main roads, which are used by more than 6 million vehicles every year, major railway lines, which are used by 60 000 trains every year, for the major airports surroundings with more than 50 000 take-offs or landings, and for agglomerations with more than 250 000 inhabitants. The creation and evaluation of the strategic noise maps was immediately linked to a creation of action

plans in 2008. Measures reducing noise, which include traffic planning, urban planning, technical measures at noise sources, selection of less noisy sources, and regulative or economic measures or incentives, have been proposed.

There are various approaches to the classification of these measures among the extensive number of measures for the reduction of the road traffic noise levels, which include measures aimed at the noise source, along the line of noise distribution, and at the receiver, and respectively on buildings. The anti-noise measures can be divided into the three following groups. Urban protective measures are among the active ones and they determine the principles for the design and reconstruction within urban planning. The main principles of these measures are related to the optimization of transport requirements and the rationalization of transport relations, and target a reduction in traffic volumes. Furthermore, they include suitable layout solutions for residential areas, the appropriate deployment of objects according to their purpose, and the architecture design of buildings. Within the set of technical measures, we could include measures aimed at the noise source (road alignment, longitudinal gradient, road pavement), measures aimed at the noise distribution, i.e. creating obstacles, which could be anti-noise walls (able to reduce noise levels by up to 15 dB), embankments, material objects, and vegetation; and measures aimed at buildings, which could increase airborne sound insulation of the external windows of buildings to be protected. The third group includes organizational measures which concern the driving speed reduction, driving speed limits at night, a decrease in traffic volumes, or a change of modal split through no access for heavy vehicles, arranging detours, and the designing of one-way roads. The issue of noise levels should be dealt with from the early stages of the urban and technical solutions, where more opportunities for useful and effective solutions are available and the results are relatively cheap. The issue of anti-noise walls is more thoroughly elaborated in Chapter 7.

3.2 Vibrations

Vibrations represent another phenomenon which negatively influences human health. In terms of physics, under the term “vibrations” the movement of an elastic body or an environment is understood, whose individual points are oscillating around their equilibrium position. The term “trembling” is used for vibrations perceived by living organism. Noise and trembling are closely connected with each other and mutually dependent. The main source of vibrations is road and railway transport in the environment. The vibrations are formed by vehicle operation on uneven road pavement and rail tracks, and they are transferred to the surrounding built-up areas through subgrade and constructions of buildings, existing near the main traffic routes, into internal residential space, and onto standing or sitting people during the movement of means of transport. We may also encounter vibrations caused by shifts in the earth's crust – impact of earthquakes or winds on various structures. The vibrations depend on vehicle’s construction, their axle pressure, speed and acceleration, the quality of road pavement, road structure and subgrade , and in case of rail transport, rail track contacts with the subgrade. Vibrations of buildings are also caused by flyovers of aeroplanes and by underground trains passing through water-bearing areas.

Vibration perception is influenced by a whole range of factors. It is a complex physiological and psychological sensation perceived by a whole range of receptors. These impulses transferred by the central nervous system to the brain, where they are integrated, and subjective sensations created. The perception size is determined not only by the frequency, but by speed as well. The exposure to intensive vibrations is connected with an unpleasant subjective perception of discomfort which could be assessed in terms of physiology, as well as psychology. Long-term exposure could cause lasting health damage. The local vibrations transmitted to the hands induce damage to some systems. The peripheral

blood vessels, nerves of upper limbs and muscular-articular apparatus are affected the most. The symptoms of changes in the central nervous system are the accompanying phenomena in the vibration exposure.

4 INACTIVITY

One of the indirect traffic effects on health is the influence on lifestyle. Car use at the expense of walking or cycling means the limitation of natural physical activity which is extremely important for health. A study which describes the situation in European cities showed that cars are also used for short distances instead of walking or cycling. More than 50% of journeys by car are shorter than 5 km which is a distance reachable by bicycle within 15 minutes and more than 30% of journeys by car are shorter than 3 km which is a distance reachable by walking in approximately 20 minutes. An average European person who lives in a city walks approximately 1 km a day, rides a bicycle approximately 0.5 km and drives by car approximately 27.5 km (THE PEP, 2004). The overuse of motorized transport is one, though not the only one, of the reasons of physical inactivity of the current European population.

The World Health Report from 2002 (WHO, 2002) states that in Europe there are approximately 17% (ranging 11 – 24%) of physically inactive people. Another 41% (ranging 31 – 51%) of people are dedicated to physical activity less than 2.5 hours a week, which is still considered to be insufficient activity in terms of the health benefits. The physical inactivity causes extensive social losses. It is estimated that it causes 600 000 premature deaths in Europe. Among the significantly affected countries there are mainly those of Eastern and Middle Europe. This situation is documented by results of various studies which deal with lifestyle of the Czech population. For example, HELEN study (SZÚ, 2006), implemented within the System of monitoring the health condition of the population in relation to the environment, and which monitored a sample of population from the ages of 45 – 54 in selected cities, discovered that roughly one third of men and women do not devote their leisure time to any movement or a sport activity, and only 10% of women and 19% of men are dedicated to an intensive activity. The international HAPIEE study (Health, Alcohol, and Psychosocial Factors In Eastern Europe) came to similar conclusions when studying the population at the age of 45 – 68 in selected Czech cities concerning the movement activity level, and, in total, one third of men and women did not have any movement activity at all (0 hours weekly) (UCL, 2005).

The lack of physical activity, as a part of lifestyle, is considered a co-affecting factor in the long list of diseases and health indicators. It increases the risk of some diseases. Among those, there are, e.g. cardiovascular diseases, diabetes mellitus of the second type, obesity, colon cancer and breast cancer, osteoporosis, and depression. Life expectancy, stress tolerance, and self-sufficiency at old age are influenced negatively as well.

The lack of movement activity is currently becoming a serious health problem. The proportion of deaths which could be assigned to physical inactivity range between 5 and 10%, with significant inter-regional differences, roughly 600 000 deaths a year, which is approximately five times more deaths than those caused by traffic accidents (WHO, 2002).

The experts' opinions on what sufficient physical activity is vary and are developed on the basis of studies which were carried out. Currently, at least 3.5 hours of medium physical activity weekly is considered to be a minimum physical activity in terms of health benefits. According to this criterion, 41% (31-51 %) of adults are insufficiently active. Approximately 17% of people in Europe are completely physically inactive. The studies carried out in 2002 in the EU showed that 2/3 of the European population do not reach

the recommended level of physical activity (Sjostrom et al., 2006). Similar results were found in the HELEN study (Health, Life Style and Environment), carried out among the population of ages 45 – 54, inhabitants of 25 selected cities in the Czech Republic. The insufficient physical activity (less than 30 minutes/ day) was found in the case of 62% respondents (SZÚ, 2006).

One of the consequences of insufficient movement is the increase in obesity among the population. The prevalence of obesity has more than tripled since the 1980s in many European countries. It is estimated that almost 400 million adults suffer from being overweight and approximately 130 million people are obese, an average BMI (body mass index) of the adult population of European region of WHO is nearly 26.5. If the current trend continues, the number of obese adults in Europe will rise to 150 million by 2010, and the number of children to 15 million (Branca et al., 2007). On the basis of the HELEN study results it was found that among the monitored population of ages of 45 – 54 there are 17.5% of obese people (19% men and 16% women) and 44% people were overweight (54% men and 34% women) (SZÚ, 2006). The reduction of physical activity, in combination with unhealthy nutrition, also leads to increasing overweight epidemics among children throughout the whole Europe. It is an alarming fact, since children's obesity is an assumption for being overweight in adulthood; this represents a higher risk of cardiovascular diseases, diabetes, etc. Being overweight through childhood could lead to hypertension, growth of LTL and a decrease of HDL cholesterol, disrupted breathing during sleep, orthopaedic problems, and psychosocial consequences (disrupted social relationships, learning problems, impact on lifestyle).

The global strategy of nutrition and physical activity and health adopted by the World Health Assembly (WHA) defines the need for a multi-sector policy supporting physical activity, among others, by a traffic policy including non-motor traffic as a part of the transport system, and provision of conditions for accessible and safe walking and cycling (Kazmarová, Rážová, 2006).

5 PSYCHOLOGICAL ASPECTS OF TRAFFIC

An important aspect of traffic, in terms of human health, is the participants' mental state in road traffic. The road traffic environment is special in its way and similarly to certain jobs, people without previous medical examination and without special training are not allowed to enter this environment. An applied psychological discipline is currently dealing with this issue; its subjects of study are the mental processes and behaviour of participants in traffic and transport, both those who actively assure these processes – vehicle drivers, crews of aeroplanes, ships, etc., and passengers, pedestrians, and cyclists. Traffic psychology is focused on mentally regulated human behaviour in specific traffic conditions which are given by individual human qualities, their preliminary preparation and training, transport mode, and means of transport. The research of the system "driver – vehicle – road" and its individual parts are included in this discipline. The reliability of this system is given by the correct functioning of all its parts. The sensory inputs (process of accepting information), process of information processing (decision-making and management processes) and the driver's decision-making are being thoroughly examined. The speed accuracy and driver's reliability and possibilities of task division between a vehicle and a driver are serious issues. Mental fitness to drive a motor vehicle means the harmony between the personal psychological characteristics and the requirements and demands which the safe operation of motor vehicles puts on people. Among the crucial aspects in the driver's traffic behaviour could be considered: visual-orientaion behaviour, i.e. observation of the road, surroundings, junctions, anticipation, reaction to obstacles, readiness

to brake, concentration and attention, psychomotorics, respectively driving techniques, i.e. movements of the steering wheel, movement coordination of other control elements, driving style with the focus on driving speed, style of negotiating curves, risky or safe driving, and last, but not least, discipline while driving, including observance of rules, road signs, restrictions, etc. What should not be omitted is the psychological vehicle analysis, which mainly concerns the information flow between the vehicle and the driver, i.e. addressing the control elements in the vehicle interior. Currently, the aim s to adapt vehicle construction to people's mental capacities, mainly in terms of their straining, which is supposed to be as low as possible, in the vehicle controlling, so that they would be able to concentrate on the road traffic in maximum extent.

6 TRAFFIC ACCIDENTS

The traffic accident rate is a significant problem in terms of the sustainability of transport systems. Not only the direct economic damage which occurs in accidents is concerned, but also the social dimension of sustainable trasnport is affetced. There are incomplete families often remaining after a fatality of their member, the injured often have lasting consequences which worsen their social relationships. Furthermore, accidents produce economic damage in connection with congestions during accident consequences elimination, medical expenses for the injured, and the loss of income.

Table 4: Development of accident rate on roads in the Czech Republic in the period between 1993 and 2006 (Jedlička et al., 2007).

Incident	Year									
	1993	**1995**	**1997**	**1999**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Accidents	152 157	175 520	198 431	225 690	185 664	190 718	195 851	196 484	199 262	187 965
Dead*	1 524	1 588	1 597	1 455	1 334	1 431	1 447	1 382	1 286	1063
Injured	32 277	36 967	36 608	37 834	33 676	34 388	35 438	34 254	32 211	28 114
Dead / 1000 inhabitants	0.15	0.15	0.15	0.14	0.13	0.14	0.14	0.14	0.13	0.11
Injured/1000 inhabitants	3.12	3.58	3.55	3.67	3.27	3.37	3.47	3.35	3.15	2.74

** within 30 days*

The most problematic transport mode seems to be road transport, mainly individual car transport. Road transport accounts for the largest proportion of dead and injured people; e.g. in 2005 it affected 33497 people in road transport, in comparison to 507 people in railway transport in the Czech Republic (MD, 2006). The people killed or injured at level crossings due to not observing the traffic rules are still included in rail transport accident statistics.

The development of the accident rate showed continuous growth until the end of the 1990s with its peak in 1999, when 225 690 traffic accidents occurred in total (see Table 4). The number of deaths was, from 1993 up until 2005, ranging between 1300 and 1600 people; it decreased significantly in 2006, which is attributed to the introduction of the point system. The traffic accidents after collisions with animals are the most apparent manifestation of fragmentation of localities by traffic infrastructure. Millions of animals are killed on roads every year at collisions with vehicles. However, a large number of killed animals does

not necessarily lead to population endangerment, but it rather indicates that the given species is very abundant and widespread. Traffic mortality in the case of common animal species, such as rodents, foxes, common birds, form only approximately 1 to 4% of the total mortality (Iuell et al., 2003). Particularly rare species of small localized populations are sensitive to traffic mortality, in which traffic is a significant cause of mortality, and additionally species which migrate frequently between localities, among which amphibians or various species of reptiles could be classified. Populations are also endangered in specially protected areas with a higher density of transport networks and high traffic volume (in the Czech Republic, e.g. České Středohoří). Other factors affecting mortality is temperature, rainfall, the season, and the day or night time. The yearly fluctuation of mortality depends on the reproduction periods, care for the young, searching for new territories by adult offspring, seasonal migration, and the time of hunting season. A higher risk of collision is on roads which lead parallel to forests or where they intersect the forest edges with grassland.

Figure 2 shows that collisions with wild animals are the second most often cause of traffic accidents in road transport, immediately after drivers' faults. The head collision usually results in death, or serious injury of the animal, but not in all cases, especially in collisions with large mammals, such as wild boar (*Sus scrofa*) or red deer (*Cervus elaphus*); the collision usually ends well for the driver and their vehicle, as shown in Table 5.

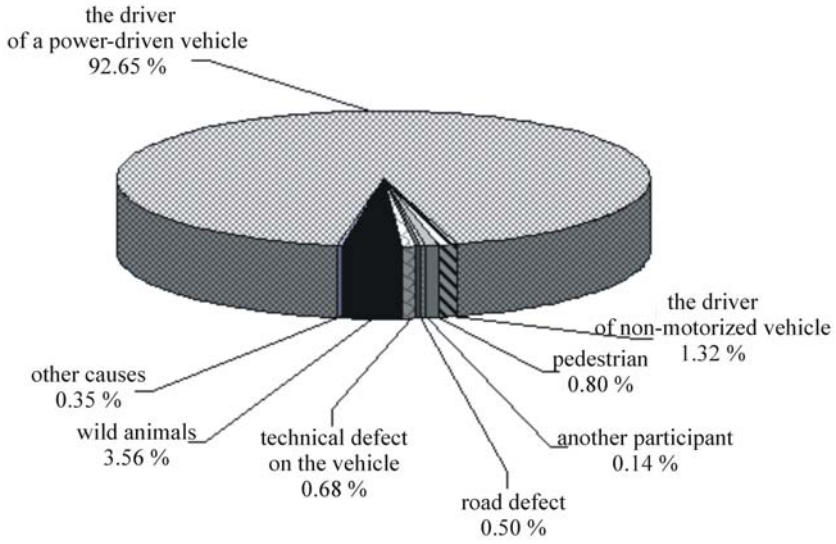

Figure 2: Traffic accidents in the Czech Republic in 2006 by offender (ŘSDP PP ČR, 2007).

Table 5: Consequences of accidents after collisions with forest animals in the Czech Republic in 2006 (ŘSDP PP ČR, 2007).

Category		Consequences
Total number of accidents with animals		6692
	number of accidents with fatalities	0
	number of accidents with serious injuries	5
	number of accidents with slight injuries	43
	number of accidents with material damage	6114
Number of killed people		0
Number of seriously injured		5
Number of slightly injured		10
Material damage (in CZK millions)		12.56

Traffic safety is a very serious factor which plays an important role in the traveller's choice of means of transport. It is ironic that air transport is a very safe way of travelling, and occasional passengers are afraid of using it. It is a consequence of the media interest in plane crashes, which are highlighted in the news more often than hundreds of smaller accidents on roads. Rail transport, which is the safest means of transport in general, is sometimes shown in a similar way. The typical case is news about accidents of a train with a road vehicle at a level crossing. In spite of the fact that in absolute majority of cases it is the fault of the vehicle's driver ignoring the warning devices, the train is often shown as the offender. This contributes to the negative image of railways in the public eye.

The White Paper on European Transport Policy (European Commission, 2001) set a goal to reduce the number of fatalities on roads by 50% by 2010 in comparison to 2001. The adoption of the National Road Safety Strategy (MD, 2005) was also confirmed by the Czech Republic. The effective measures, both in the area of improving the safety of vehicles and traffic infrastructure, and in training and education of drivers, are necessary to be taken so that this goal can be met. The introduction of the point system for traffic offense penalties in June 2006 (Act no. 361/2000, Sb.), which led to a quick decrease in the number of accidents and fatalities as well, has been a very important moment in this respect. However, it is not sure if it only reflected drivers' immediate reaction to the system of strict sanctions, which they would lose respect of very soon, or if it has really managed to apply measures with long-term benefits in practice.

7 SUMMARY

Transport, especially road and air transport, is an economic sector which is growing globally in most of the indicators (energy consumption, number of vehicles, transported volumes, etc.) much more quickly than corresponding GDP values. The damage to the environment and human health is increasing proportionally. The quantity of cars, in spite of various reduction measures, is rising from year to year, which is reflected in the emission growth resulting from traffic. The emissions from transport contain a whole range of dangerous chemical pollutants, all with demonstrable negative effects on human health, particularly under prolonged exposure. Similar effects, often more serious than the emission effects, come from other negative traffic features, such as noise, inactivity, and traffic accidents.

As can be seen from the above, the issue of negative influence of traffic on human health is gaining considerable importance, and is becoming one of the priorities, not only in the Czech Republic, but worldwide. A range of international events, aiming to find a solution to this issue, such as the Charter on Transport, Environment and Health, the Regional Conference of EHK/UN on Transport and the Environment etc., reflect this fact.

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The Possibilities for Mitigating Negative Effects of Transport

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ABSTRACT: The success of the correct execution of designed measures depends on our succeeding in reducing the negative influences of transport on health and the environment; however, to eliminate these negative effects it is almost always necessary to take more measures. In this case we speak of a set of measures which are inter-connected, and their efficiency is thereby enhanced. As an example, it is possible to mention the increase of the positive influence of a new service of urban public transport on the reduction of car transport, together with the building of an park and ride facilities in a suitable area on the public transport service route. From the design stage of the measures to their implementation it often takes a long time, therefore the complex of the measures should always be designed by a team of experts who are capable of judging the efficiency of various alternatives and subsequently design an optimum solution.

KEY WORDS: transport, mitigation, measures, impact on the environment.

1 INTRODUCTION

In the field of influences of transport on health and the environment, a primary task is to take such measures which would eliminate, or at least mitigate, negative effects. It is a task not only for the government, but for regions, towns, and communities as well. It is necessary to realize that the negative influences of transport are a result of the behaviour of people, and their everyday decision-making process whether to go on a journey, where to go, which means of transport to choose, and which route to follow. A range of factors has an influence on this decision-making: mainly social-economic characteristics of the population and their relation to the environment and the properties of the available transport systems (travelling time, costs, comfort and safety of the individual modes of transport). This is the basis for another goal of the measures – to influence the transport behaviour of the population for the benefit of the most environmentally friendly modes of transport.

The measures could be divided to supply measures – e.g. building of the new infrastructure with safety and environmental elements, higher quality means of transport, and management of transport systems – and demand measures, which should lead to the limitation of demand for harmful modes of transport.

The demand measures include the management of mobility, higher parking fees, limited car traffic in the city centres, closer of origins and destinations within transport planning, etc. The measures outside of the above mentioned are the so-called soft measures, which include

an integration of public in the decision-making about transport projects, environmental education of the population, "eco-driving", etc.

Table 1: Scheme of the measures classification.

Measures on roads	Anti-Noise protection measures	- anti-noise walls
		- constructions along roads (houses, garages) preventing noise propagation
		- natural embankments
		- green strips
		- low-noise road surfaces
	Protection against contamination of waters and soil	- sedimentation tanks
	Measures for fauna protection	- ecoducts ("overpasses")
		- adjustments of road crossing watercourses
		- dry tunnels and bridges
		- culverts
		- guide fences
Measures on vehicles	Devices burnt fuel treatment	- 3-way controlled catalytic converters
		- oxidation catalytic converters
		- recirculation of exhaust gases
		- particulate filter
	Reduction of noise of vehicles	- noise reduction from drives
		- noise reduction from sucking and exhaust devices
Legislative measures	Emission limits	- introduction of European norms EURO 1-5 for new vehicles
	Noise limits	- introduction of European standards in the new vehicles
	Economic and tax tools	- charging for use of the transport infrastructure
		- discounts for road tax for the "more environmentally friendly" vehicles
		- excise tax on fuel
Improvement of fuel quality		- ban on leaded petrol
		- reduction of content of sulphur in petrol and diesel
Support of public and multi-modal transport	Increase of attraction of public transport	- introduction of integrated transport system (IDS)
		- increase of the comfort for passengers
		- preference of public transport
	Support of the combined transport	- introduction of the system "Park and Ride"
		- introduction of the system "Bike and Ride"
		- systems of the combined freight trasnport
Mobility management		
Environmental education, education, and enlightenment		
Integration of public in transport projects		
Eco-driving		
Land use planning		

Source: Transport Research Centre

2 MEASURES ON ROADS

The measures on the roads are very varied, because they concern various effects of the transport infrastructure on the health of population and the environment. The road represents a source of noise from vehicle traffic, causes pollution of the surrounding environment through drainage water, and last, but not least, it works as a barrier effect, which leads to the restriction of the movement of wild animals.

2.1 Anti-noise measures

The anti-noise screens are installed in order to protect the health of the population from the effects of noise. The aim is to reduce noise from road transport to limits specified in hygienic regulations. The following types of the walls are recognized: anti-noise walls, buildings (houses, garages), earth embankments (natural or artificial), and strips of vegetation (Ďurčanská et al., 2002). Well designed barriers brings on average a reduction of noise of approximately 4 and more dB (A), depending on the conditions (geometry) of the traffic noise propagation. It is generally accepted that the required efficiency is assured if the source of noise is not visible from any place of the receiver, then the energy only moves through diffraction or reflection of sound waves. In order to assure the maximum acoustic effectiveness, the anti-noise barriers should be located as close as possible to the source of the noise. Furthermore, it is desirable that the character of the barriers eliminate the undesirable reflection of the sound and that the barrier blend in with the environment, if possible. Attention should be paid to the edge of the barrier as well, so that vehicles on the road are not threatened by a sudden change in the dynamics of the wind streaming (Haberl, J. et al., 2005).

An urban solution with the use of barrier houses, multi-storey garages, and other screening "objects", is often used. The earth embankments are, compared to barriers, more demanding on the land use, and, due to their higher distance from the top of the hill to the road, they have lower reducing effects as well. However, planting vegetation at the top of the embankment can influence these effects in a very positive way. The disadvantage of the earth embankment is their demanding land use. The strips of vegetation have a bioclimatic, hygienic, architectonic and aesthetic function. The spread of noise in the vegetation gets absorbed thanks to the absorptiveness of tree leaves and the Earth's surface, and the multiple dispersal on trunks and branches. The vegetation (not only) along roads influences in a positive way the quality of air and health of people as well, because it captures dust particles and transforms the carbon dioxide into oxygen via photosynthetic processes. Because the perception of noise is rather individual and depends on actual mental condition of a person, the vegetation can considerably reduce the harmful effects on the health of people, because the noise objectively does not change.

2.2 The low-noise road pavements

Low-noise road pavements play an important role within communities and cities, in which the anti-noise barriers cannot be constructed due to insufficient space, the necessity to provide unobstructed access to roads, or due to aesthetic reasons. Noise reduction through road pavement represents a real measure at the source. Each road pavement is, during its use, deteriorating due to impairment caused by vehicles, which can lead to an increase of noise by up to 3dB. The extensive European research project SILENCE has, among others, dealt with the issue of noise between tyres and the road pavement (Bendtsen & Schmidt, 2006). On the basis of experimental measurement of noise of the surfaces by the method CPX (Close Proximity Method), the project designed an acoustic evaluation of road pavement

through three degrees of damage: good condition (+0 dB), favourable condition (+1 dB) and unfavourable condition (+2 dB and more).

Due to insufficiently clear evaluation of the noise levels of the individual surfaces, the five classes of noise of road pavement were defined as well: very noisy (reference pavement + 3 dB and more), noisy (reference pavement + 1 up to 2 dB), normal (reference pavement), silent (reference pavement – 1 up to 2 dB) and noise reducing (reference pavement - 3 dB and more). For the reference pavement bituminous concrete is considered with a maximum aggregate size of 11 mm up to 12 mm or road pavement with a similarly fine surface structure.

2.3 The protection from contamination of water and soil

For the protection from potential contamination of water and soil, sedimentation tanks are used into which drainage lead draining the rain water out of the surface of road pavement. The drained water is gravitationally removed from suspended particles heavier than water, and from liquid particles lighter than water. During the sedimentation and retention of the water in the tank, partial degradation of the organic matter could also occur owing to the activity of microorganisms. The process of biological cleaning of drainage water, drained from the road surface, is also used in retention tanks. The sedimentation and retention tanks are in the Czech Republic found mainly alongside motorways and dual carriageways with high traffic volume.

2.4 Ecoducts and passages for fauna

Ecoducts and passages for fauna are used for mitigating the effects of the fragmentation of the localities by the transport infrastructure. There are methodologies produced at the national (Anděl et al., 2005) and international (Iuell et al., 2003) levels for the construction of ecoducts and passages. With the construction of new roads it is very important to take into account the already existing transport networks or other barriers. In the countries of Western Europe a principle is used that in the case of multi-modal transport corridors it is suitable to locate individual routes as close to each other as possible.

The design, density and location of the passages for fauna are very important as well. The passages should be designed in cooperation of the designer with an environmental expert, and should be focused on one or more specific species. The total migration significance of the area and other barriers in the surroundings (e.g. the above-mentioned original roads) have to be taken into consideration when deciding on the location of the passage. It is suitable to locate the passage at a place where parallel transport networks come close to each other. The dimensions of the passage (bridge, culvert) as well as the character of the underpass should correspond with the size of the species. An underpass with foreign elements is unsuitable: paving, concrete, sharp stones, handrail, etc. Planting of the underpass with the original vegetation and bushes is suitable, not only in terms of passability, but also in terms of monitoring passing animals as well. The specific solution is the so-called overpasses, which are constructions designed for the migration of animals over roads. Owing to their financial cost, they are recommended only in really justified cases, after negotiation with bodies for the protection of nature. In developed countries overpasses are common solution, they are mostly constructed in a way that they are narrowing down towards the centre of the road and they get wider towards the edges (Iuell et al., 2003). It is suitable to build overpasses in the localities where the road runs deeper in the ground and the surrounding terrain is elevated. They are usually pointless on flat terrain.

The fencing for the whole length of the road is most commonly used for prevention of accidents between animals and vehicles. The continuous fencing on the one hand reduces

animal fatalities, but, on the other hand, increases the barrier effect of the given road. Currently fences in the shape of “V” are more recommended in the surroundings of the passages, which guide the animals through the passage. In the case of fencing for along the whole length of road, it is more suitable to locate the fences between road and the edge of a forest. If the fence runs along the edge of a forest, or even in a forest, it is often overlooked by animals, so it works as a trap. Some sections of older motorways make almost insurmountable barriers, because, at the time of their construction, the aspect of fragmentation was not really taken into consideration. The most common barriers in the case of old bridges are "cascade" layout of the watercourse, too small passages, low height, absence of vegetation, inconvenient underpass, etc. In these cases the extension of unsuitable bridges and adjustment of their underpass should be included in the plans of a reconstruction of the motorway and road network.

3 MEASURES ON VEHICLES

In this chapter not only technical, but also legislative measures are included as well – emission limits, which directly concern the issue of vehicles. Emission limits are directly related to technical measures, because new stricter limits directly force the car producer to further technological improvements.

3.1 Emission limits and renewal of vehicle fleet

A very significant contribution to the reduction of effects of transport on the health of the population is the renewal of vehicle fleet. The decommissioned vehicles are mostly older types, with a non-functioning catalytic converter, or without any catalytic converter, and tend are usually replaced by new vehicles which meet stricter emission standards. The Czech Republic uses the system of emission limits EURO 1-5 for road vehicles, which is used in all countries of the EU. Since 1 October 2006 the registration, sale, putting into operation, and use of new heavy vehicles with an emission limit lower than EURO 4 are not allowed, with the exception of vehicles intended for export to developing countries or spare motors for the vehicles in operation. The ban on registration of passenger and light freight vehicles with the emission limit lower than EURO 4 has been in force since 1st January 2006. The new, stricter emission limits EURO 5 have been effective in all EU countries for new vehicles since 1st January 2009. The limits EURO 5 mostly reduce the emission limits of particulate matter – five times more compared to the EURO 4 standard. This limit can be met by car producers only with the installation of effective micro filters. More detailed circumstances about the legislation referring to emissions from transport are mentioned in the respective chapter.

Table 2: Emission limits EURO for passenger cars with petrol engines (Directive 70/220/EEC).

Limit	Year	CO ($g.\ km^{-1}$)	HC+NOx ($g.\ km^{-1}$)	HC ($g.\ km^{-1}$)	NOx ($g.\ km^{-1}$)	PM ($g.\ km^{-1}$)
EURO 1	1992	2.72	0.97	-	-	-
EURO 2	1996	2.2	0.5	-	-	-
EURO 3	2000	2.30	-	0.2	0.15	-
EURO 4	2005	1	-	0.1	0.08	-
EURO 5	2009	1	-	0.1	0.06	0.005

Table 3: Emission limits EURO for passenger cars with diesel engines(Directive 70/220/EEC).

Limit	Year	CO (g. km^{-1})	HC+NOx (g. km^{-1})	HC (g. km^{-1})	NOx (g. km^{-1})	PM (g. km^{-1})
EURO 1	1992	2.72	0.97	-		0.14
EURO 2	1996	1	0.7	-		0.08
EURO 3	2000	0.64	0.56	-	0.5	0.05
EURO 4	2005	0.5	0.30	-	0.25	0.025
EURO 5	2009	0.5	0.23	-	0.18	0.005

Table 4: Emission limits EURO for heavy vehicles with diesel engines (Directive 70/220/EEC).

Limit	Year	CO (g. kWh^{-1})	HC (g. kWh^{-1})	NOx (g. kWh^{-1})	PM (g. kWh^{-1})
EURO I	1992	4.5	1.1	8	0.36
EURO II	1996	4	1.1	7	0.25
	1998	4	1.1	7	0.15
EURO III	2000	2.1	0.66	5	0.1
EURO IV	2005	1.5	0.46	3.5	0.02
EURO V	2008	1.5	0.46	2	0.02

3.2 Emission reduction devices

The reduction of pollutant emissions by vehicles is reached through an improvement of the combustion engine and mainly devices for the adjustment of burnt gases, catalytic converters. The first vehicles with catalytic converters started to appear on the road in 1975. Petrol vehicles are currently equipped with three-way catalytic converters, containing an oxidation and reduction part. Diesel vehicles are equipped only with an oxidation catalytic converter. The producers of heavy vehicles were forced, by a strict reduction of the emission limits of nitrogen oxides (NOx) in the burnt gases, to develop new devices for the adjustment of burnt gases. There are currently two types of heavy vehicles on the market, those with the system of adjustment of burnt gases EGR- recirculation of the exhaust gases, or SCR-selective catalytic reduction, which can both meet the emission limits EURO 5.

The technology EURO 5 uses an additive with the name AdBlue (pure colourless liquid composed of 32.5% Aqueous Urea Solution), which is injected into exhaust gases before they go through the catalytic converter SCR. In the catalytic converter nitrogen oxides are transformed into nitrogen and water vapour. The advantage of the method using SCR is the fact that it could be modified in a way that would make it compatible with the requirements EURO 5 and EURO 6 as well. For example, in the case of motors EURO 5, more of the additive AdBlue is injected in order to reduce the content of nitrogen oxides. In case of standard EURO 4, the quantity of the additive is approximately 3-4% of the fuel quantity, and at the standard EURO 5, approximately 5-7%. EGR is a system of recirculation of the burnt gases.

In order to reach the lower temperature of burning, which reduces the emissions of nitrogen oxides to the required level, the regulated quantity of the exhaust gases, up to 18% of EURO 4 and 25% of EURO 5, cools down in the EGR cooler and returns back to the motor. The emissions of particulate matter (PM) is reduced by the high pressured

injected system. The current situation and developing trend in the equipment of vehicles with catalytic converters in the Czech Republic is apparent from the following Table.

Table 5: Number of vehicles per type and emission category in 2009 (Adamec et al, 2010).

Type of vehicle	EURO I	EURO II	EURO III	EURO IV	EURO V
Passenger cars and LDV	488.4	1 166.1	1 151.4	842.0	179.2
Heavy vehicles	11.9	14.2	41.1	31.1	16.0
Buses	1.39	2.14	5.50	2.81	2.25
Total	501.66	1 182.42	1 198.02	875.86	197.47

The classification of vehicles according to their equipment with catalytic converters comes from the statistics of the Central register of vehicles. In relation to the speed of the renewal of vehicle fleet, the number of vehicles equipped with catalytic converters is increasing. But the vehicles with catalytic converters drive considerably more kilometres than older vehicles without catalytic converters.

Therefore, in traffic, considerably more vehicles equipped with the catalytic converters are represented – even up to 95%.

3.3 Reduction of noise of vehicles

The possibilities for noise reduction can be divided into the reduction of noise of the fuel unit, reduction of the sucking noise and exhaust pipe noise, and the noise reduction of the tyre/road pavement (the so-called rolling noise).

The rolling noise comes from the friction of tyres on road pavement,and depends on the speed of driving (Hensher & Button, 2003). In the past it played a less significant role when considering the high limit values of external noise of motor vehicles, as it was exceeded by the noise from the drive unit. The noise of the drive unit depends on the revolutions of the engine and the load of the engine, but not on the speed of driving.

The gradual limitation of the level of noise from the sucking and exhaust devices led to a decrease in the values of the external noise of motor vehicles. Currently, the noise from the drive unit is only dominant at starts, when accelerating, or when braking by the engine. At higher speeds, the rolling noise of the tyres on the road pavement starts to predominate in the acoustic emissions from the vehicle. The rolling noise depends on the tyre, to be more precise, on the production of better surface texture (thread) of the tyre and on the development of low-noise surfaces of road pavements. The road pavement, mainly surface texture, influences the noise of the vehicle at the place of its origin and has an influence on its propagation.

4 IMPROVEMENT OF FUEL QUALITY

A reduction of emissions of certain pollutants is also assured by the increasing qualitative requirements on car fuels. In 2001 the distribution of leaded petrol finished in the Czech Republic. Since 2000 the emphasis has also been placed on the reduction of sulphur content and other pollutants in the petrol and diesel.

At present, fuel with a very low sulphur content is distributed in the Czech Republic, mostly meeting the requirements for sulphur content from 2009. The maximum permissible contents of individual pollutants in petrol and diesel are mentioned in Table 6.

Table 6: Requirements on the content of pollutants in car fuels.

Automobile petrol	since 1 January 2000 *	since 1 January 2005
max. sulphur content [mg. kg^{-1}]	150	50 (10)**
max. benzene content [% volume]	1.0	1.0
max. content of aromatics [% volume]	42	35
max. content of olefins [% volume]	18	18
max. content of oxygen [% weight]	2.7	2.7
max. content of lead [mg.l^{-1}]	13	13
Motor diesel		
max. sulphur content [mg. kg^{-1}]	350	50 (10)**
max. content PAH [% volume]	11	11
min. cetane number	51	51

* *values have become effective in Czech Republic since 1st January 2003, on the basis of the Announcement Ministry of Work and Trade No. 227/2001.*

** *the values mentioned in the brackets came into force on 1st January 2009.*

Another important measure is the gasification of vehicle fleet of public transport operators. Older vehicles are replaced with newer compressed natural gas (CNG) vehicles, which emit several-fold lower amount of emissions of pollutants than diesel buses.

5 THE SUPPORT OF ENVIRONMENTALLY FRIENDLY MODES OF TRANSPORT

One of the important tools to mitigate negative influences of transport is a change in modal split to more ecologically beneficial modes of transport. These modes of transport predominantly include rail, public, and non-motorised transport. Public transport should be sufficiently attractive in order to motivate the population to use this transport mode more often. There are a range of possibilities to improve attractiveness of public transport, however not all of them are always suitable for specific situations. It is necessary to carefully combine these methods under local conditions.

5.1 Increasing attractiveness of public transport

a) Introduction of integrated transport systems (IDS)

Integrated transport provides transport services of an area via public transport with the use of individual road transport operators, or road transport operators together with operators in another transport mode, or by an operator operating more transport modes. Therefore, the individual operators and transport modes do not compete with each other in IDS, they try to cooperate in order to gain new customers from the group of users of passenger cars.

The unified rules for the operation of IDS are not provided, and they differ from case to case, but it is always based on the voluntary agreement of the operators. Usually, this type method includes enforcement of a unified tariff policy (on one travel ticket is possible to travel on the whole network with various operators), mutual interconnection

of the timetables of the integrated carriers and the creation of the new change hubs, elimination of parallel services of more carriers, and creation of a timetable for services going in a regular intervals. In the Czech operators, 13 IDS are currently being operated with different levels of integration. Prague, Ostrava, and South Moravian region are among the biggest and most elaborated systems.

b) Increase in comfort for passengers

In order to increase the comfort during travel, modern, low-floor vehicles, allowing for easier entry and exit of passengers have been put into operation; these are also suitable for the transport of the impaired and mothers with prams. A necessary procedure for urban public transport is the equipping of quality information systems for passengers. The construction or modernization of change terminals is being carried out to facilitate the easier movement of passengers, with the introduction of edge-edge change system (services leave from different sides of one platform so passengers do not have to go to other platforms through underpasses, overpasses, or even directly across the road), and sufficient maintenance providing higher comfort of travel. Other elements enhancing the comfort of travelling by public transport are, e.g. air-conditioning, cleanness, and interior design, etc.

c) Preference of public transport vehicles

The vehicles of public transport are slowed down by automobile transport, mainly in cities. One of the assumptions for an attractive public transport is the sufficient travel speed. Therefore, preferential measures are being introduced, e.g. the introduction of designed lanes for buses and trolley buses in busy locations, or the preference the urban public transport vehicles at traffic signalled junctions.

5.2 Introduction of systems "Park and Ride" and "Bike and Ride"

a) Park and Ride

The system "Park and Ride" (P&R) means that the driver travels a part of his journey by car from the place of residence to a car park, where they change to a public transport vehicle, in which they continue their destination. This system should be combined with higher rates of parking fees in localities which are to be calmed (mainly in city centres), or with the introduction of fees charged for entrance to these localities. The necessary assumption for the realization of this system is the construction of parking houses and P&R car parks. In towns it is recommended to build P&R car parks in outskirts, at places of important hubs of urban public transport. Outside urban areas it is recommended to build such car parks mainly at the main rail stops leading to a central town of a given region. The parking policy should put off drivers from entering city centres, e.g. by increasing fees, and also motivate them to make multi-modal trips, i.e. partly by car and partly by urban public transport.

For the installation of P&R it is necessary to ensure clear directing road signs (signs for the car park, with the letters “P&R”) and ensure more services of urban public transport at the localities in question. The payment for parking should be reflected in the price of the fare. In order to ensure the maximum use of the car parks, locations should be chosen on the basis of socio-economic research of transport behaviour and demand for P&R, and a subsequent modelling of wider transport relationships of the given area (Lee-Gosselin & Doherty, 2005).

The psychology of car drivers, who are now used to driving all the way to their destination, represents a certain obstacle in the implementation (efficiency) of this measure. It will probably take a long time before at least some people will willingly leave their vehicles, even though in car parks with surveillance, and continue by public transport. The drivers should have financial motivation for this measure, e.g. the parking ticket price should be incorporated into the price of the ticket for the urban public transport.

b) Bike and Ride

The system "Bike and Ride" (B&R) is similar to the system "P&R", only instead of a car a bicycle is used, from the origin of the trip (place of residence) to a car park, or to a building for the storage of bicycles. After parking the bicycle the cyclist exchanges bike saddle for a public transport seat and continues until completing the trip. Whereas car drivers are usually not prevented from parking their car in a suitable place and continuing to their destination by public transport, cyclists usually have no opportunity to leave their bicycle without supervision at urban public transport stops. This system should allow for the storage and safe parking of bicycles, mainly at the end stations and important hubs of urban public transport. The existing parking areas or public places under the ownership of the city should be preferred. The buildings for the storage and parking of the bicycles could have, e.g. a form of a "cage", or special stands, with a fence and lockable doors, which can be opened by a card or coin. The measures should also make bicycle transport more attractive for people who are less physically capable, and who would like to use a bicycle for commuting to work, but for whom the completion of the whole route, from the place of residence to the workplace would be a strenuous physical activity on bicycle. Another possibility is the combination of the system B&R and P&R in areas where these options are possible together. The bicycle storage should, in this case, be located directly at the car park.

5.3 Systems of freight combined transport

Not only the transport of people, but also freight transport can be executed in a multi-modally. In terms of mitigating the effects on the health of the population, goods should be transported on rail at the highest possible degree. Water transport is considered "environmentally friendly" transport as well, but this is debatable considering the negative effects on water ecosystems. In this perspective, road transport is considered to be the least environmentally friendly. However, rail transport is not able to handle the total transport of goods to its destination, i.e. "from door to door". Therefore, the transfer of all transport of goods from road to railway is unrealistic.

However, a part of the transported volume of selected commodities is possible to be transferred to railways, with the help of building logistics centres at important railway stations. Places for the storage of goods should be built, and from there goods are sent on freight vehicles to target destinations. This combined option for freight transport should then be offered to fright operators, who are particularly interested in these services for foreign transport. The areas for the placement of logistics centres have to have a direct connection to the main railway routes.

The access for heavy vehicles should run outside of the built-up areas. Equipping the station with a rail siding is beneficial. The building of logistic centres can be one of the ways how to revitalize unused premises, i.e. "brownfields" (these tend to be rail-sided, there are storage and loading spaces, etc.). Each proposed solution for logistics centres should be evaluated from the freight transport perspective.

5.4 Bicycle transport support

The aim, of this measure is to build a compact network of cycle paths which guarantees a relatively quick and safe connection of important origins and destinations, not only recreational ones, but predominantly from places of residence to workplaces. The designing of specific cycle paths should be preceded by a production of a general development plan (or a study) of cycle trail network.

The general development plan determines the proportional rate of investments in bicycle infrastructure considering the needs of cyclists. The designed and gradually implemented network of cycle paths should meet these basic principles: coherence of the network, interconnection of the origins and destinations, and the attractiveness of the paths in terms of length, safety, and general comprehensiveness. Within the road arrangement a suitable cycle path is designed and its suitable alignment is recommended. The cycle paths should be conveniently separated from motorised transport: e.g. with an edge line, central resere (green), kerb, fence, or safety barrier (Bartoš, 2006). It is suitable to use the road alignment along watercourses, and along the so called "greenways" in the vegetation. In the cities the bicycle infrastructure should be completed with buildings for storage and safe parking of bicycles (see Chapter 5.2 - "Bike and Ride").

6 MOBILITY MANAGEMENT

Mobility management is an approach focused primarily on demand in passenger and freight transport, and therefore is sometimes translated into Czech as transport demand management. It tries to change the attitude and behaviour of the population towards sustainable types of transport.

The tools for the management of mobility are based on informing, communication, organization, and coordination. Mobility management is different from traffic system management, which is an approach focused on the supply, which tries to optimize the capacities of traffic corridors with telematics methods, pricing systems, etc. However, some tools could be similar in both approaches; management of traffic system is more focused on the solution of the final approach ("end of pipe approach"), whereas mobility management precedes this approach, and is therefore more preventive and systemic. For mobility management the influence of human choice on traffic is especially important before people decide how, where, and whether they travel.

The establishment of mobility management responded to the need of such approaches in the solution of a burning issue of ever-growing demand for mobility, which simply does not rely on building of new roads or the introduction of advanced technologies. Apart from these "hard" measures, there is an urgent need for more "soft" measures which will provide a wide range of services satisfying the needs of users and influencing them to change their transport habits towards sustainable transport. Management mobility specifically consists of providing information and consultation including, e.g. cycle maps, freight transport maps, itineraries of organizations, maps of the availability of schools, companies and other organizations, information on the possibility to change public transport, timetables, and other information.

It further deals with consultancy activities in the sense of analysis of availability and designing of alternatives and recommendations, such as transport plans of organizations or a comparison of different transport modes in terms of travel time, costs, and effects on the environment.

7 ENVIRONMENTAL EDUCATION AND AWARENESS

Changes to the transport system which should mitigate the effects on health and the environment, are not possible without the wide support of the public. Furthermore, these changes have to be designed at a high professional level and, therefore, the transport experts have to be educated appropriately and motivated in the field of the environment. Last, but not least, the political support for the projects which would lead to a reduction of negative impact on the environment is necessary. These three groups – the public, experts, and political representation – are crucial for the desired changes.

The environmental education has to start already with children, in order to have a chance for greater success. The environmental education has already been established as a subject in primary schools. Unfortunately, it is still rather a marginal subject and often its content is still inadequate for the matter which it concerns. This is caused by, among other factors, the fact that there is no sufficient education of the environmental education at education faculties, where the so-called environmental minimum has not yet been fixed.

This is necessary to ensure that the graduates of the faculties master the rudiments of the environmental education. As far as the integration in education of the issue of transport, health, and the environment is concerned, the situation is even less favourable. An example of the integration of the environmental and human aspects of transport in education could be the Methodical instruction "Transport and the environment" intended for primary and secondary schools, published by the Club for Environmental Education, on which compilation the employees of Centrum dopravního výzkumu (CDV) participated. Outside of the field of education, the highest attention is paid to environmental education from the perspective of non-governmental, non-profit organizations (NGO). However, they are unable to cover all involved population within the whole issue.

From the research carried out with primary schools' students it was discovered that the ability to act in an environmentally friendly manner, according to the knowledge gained through environmental awareness, was almost entirely missing. There is a struggle between old and new values for students, whereas environmental values in the conflict with competitive ones are clearly losing.

The transport behaviour is motivated by speed, comfort, and the attractiveness of transport, not by the pursuit of sustainable transport and meeting the fundamental principles of sustainable development.

8 THE INVOLVEMENT OF THE PUBLIC

It is necessary that the public is involved in the process of transport planning and decision-making. In this respect, the transport planning field has limited historical experience. The planning processes are, in many cases, reserved mainly for transport experts, politicians, and state administration officials. This is particular the case of countries with a short duration of democracy, among which the Czech Republic is rated.

Decision-making in the so-called young democracies is often characterized by technical rationality, decision-making directed "from above", and is often linked to lengthy bureaucratic procedures. This model of decision-making is possible to be called democratic elitism. The key decisions tend to be made by a small group of oficials and politicians, and if some participative techniques are used in the decision-making, they are chosen and executed in a way that guarantees the support of the official form of the project and contradictory opinions were eliminated.

The opposite of democratic elitism is a model called participative democracy. An important characteristics of this model is the necessity for direct involvement of the public in the decision-making. In this case, the public has a direct influence on the final form of the project, because the differences between the expert and layman opinions are minimized. The decision-making is based on the availability, cooperation, negotiation, and interactivity. From the many examples in practice it is apparent that the thoroughly planned and realized participation of the public could contribute considerably to decisions of higher quality. The early integration of the public in the evaluation of transport needs and the alternatives of transport decisions leads to the fact that the population accepts the decisions "for their own benefit", tolerates them more easily, and accepts the negatives of the implemented transport projects better as well.

According to the law, citizens have the possibility to get involved in the decision-making process for the approval of land use plans and their changes. However, this opportunity is not used very often by the public. In case of the extensive projects (and, of course, not exclusively of these projects) it is a necessity to plan and realize the participation of the public in an exceptional form already within the phase of the creation of the alternatives, e.g. in the form of round-tables, workshops, discussions, planning weekends, etc. During the whole project, the citizen should be considered an equal partner, and the opinions of the public should be reflected. The insufficient possibilities of the involvement in the negotiation of transport plans can even lead to efforts by the public to announce a referendum about a given construction (e.g. in the case of the planned transfer of the railway hub Brno). Similar initiatives represent a clear signal that citizens want to co-decide on the form of the city in which they live.

9 ECO-DRIVING

"Eco-driving" or "environmental driving" is a method of driving which reduces the consumption of fuel, emissions of greenhouse gases, and the number of traffic accidents, and which brings benefits, not only to the environment, but mainly to drivers of motor vehicles. Driving the vehicle in accordance with the principles of "eco-driving" reduces the consumption of fuel by 10% or even more. Included in the fundamental elements of this method of driving, there are: maintaining a constant speed of the vehicle, the prediction of transport congestions and the finding of alternative "free" routes, gradual acceleration and braking, and regular checking of pressure in tyres.

The promotion of the principles of "eco-driving" in practice plans an international campaign which will be coordinated at a European level through the project ECODRIVEN. The goal of the campaign is to motivate at least 2.5 million drivers of passenger and freight vehicles in Europe to drive safer and in an energetically more efficient way, and reduce the emissions of CO_2 by 0.5 million tons in 2010.

10 LAND USE PLANNING MEASURES

The production of land use plans is part of very significant measures for the reduction of transport impact on the environment. The land use plan is a preventive tool which deals with the causes, not the consequences.

With the help of quality land use plans it is possible to achieve a reduction in the need for travelling and length of trips by car transport (through building of residential estates with good job opportunities), changes in modal split in favour of environmentally more friendly transport modes (e.g. building fast lanes for public transport),

and, last but not least, the diversion of traffic from places where the population is directly exposed to emissions and noise from cars (planning of new roads, bypasses of cities and towns, etc.)

11 OBSTACLES TO IMPLEMENTATION OF THE MEASURES

11.1 The acceptability of the measures for the public

A lot of people use only passenger cars for all their transport needs. The measures which somehow restrict car traffic could be understood by this group of the public in a very negative way. It concerns mainly the charging of entrance to city centres, higher parking fees, environmental taxes on fuels, etc. In this respect the promotion of the measures is, mainly at the level of cities, very unpopular, and very hard to accept in terms of politics.

For example, in the field of air pollution, cities and regions are, according to the law, obliged to produce programs for the improvement of air quality, define the areas with a worsened quality of air, and design and implement the necessary remedial actions. The unpopularity of the measures which limit car traffic tend to be a cause for the shortfalls of these programs – the designed measures often stay only "on paper".

On the other hand, other measures tend to be welcomed by the public, e.g. cycle paths, new public transport services, or buses running on natural gas. Other measures could provoke different reactions: e.g. part of the public favourably reacts to the construction of new roads; the other part criticizes the construction.

11.2 Other obstacles for implementation

The measures designed in regional and city programmes are usually of cross-section character, and therefore their realization cannot be handled by simply one department of the corresponding authority. The issue concerns the departments of the environmental, transport, land use planning, and finance. The individual departments often have completely different opinions on the measures that should be implemented in a given locality (particularly the departments of transport and the environment). The solution to this issue is not simple. Nevertheless, the work groups composed of representatives of all concerned groups should be created for the implementation of the measures (programmes).

The work group should plan specific courses of action and their time schedule, choose the suppliers, monitor the progress of the implementation of the measures, etc. It is desirable that the producers of the programmes and general development plans containing the designed measures were represented in the given group.

In connection with the application of the reduction measures a question logically arises how financially demanding they are. However, not all of them are quantified in terms of costs. Specific actions (the building of infrastructure, purchase of vehicles, etc.), which differ very much financially concerning the used technology, material, type of vehicle, etc., could be quantified the best. The overview of the investment expenses on selected measures is shown in Table 7.

Table 7: Investment expenses of selected measures (pricing level in 2006).

Measure		Price
Support of the environmentally friendly transport modes	- modernization of rail corridors, including the rail hubs	CZK 100 mil. / km
	- low-floor tram	CZK 20-40 mil..
	- low-floor trolley-bus	CZK 8-12 mil.
	- low-floor bus	CZK 4.5 mil.
	- low-floor bus on CNG	CZK 6 mil.
	- car park - area	< CZK 1 thousand / m^2
	- car park – parking building	CZK 0.5 mil. / 1 stay
	- storage of bicycles	< CZK 1000 / m^2
	- cycle path	CZK 2-4 thousand / 1 m
Anti-noise barriers		CZK 5 - 7.5 thousand / m^2
Protection of wild animals	- ecoduct	CZK 200 mil.
	- fencing	CZK 60-120 thousand / 1 km

Source: Ministry of Transport

12 SUMMARY

Whether the negative effects of transport on health and the environment can be reduced depends on the success of the correct implementation of designed reduction measures, and for the elimination of these effects it is almost always necessary to adopt more measures. In this case there is a package of measures that are consistent with each other and their effectiveness is greater. As an example, it is possible to increase the positive impact of a new public transport service on the reduction of car transport together with building a Park & Ride system in a suitable location on its route. From the draft of the measures to their implementation takes a long time, and, therefore, measures should always be designed by a team of professionals who can assess the effectiveness of different alternatives and subsequently design the optimum solution.

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Sustainable Development and Transport

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ABSTRACT: Transport is one of the crucial factors in the development of individual countries. However, there is a constant contradiction between society, which requires ever higher mobility, and the public opinion, which is less and less tolerant towards the negative impact transport has on the environment and health, chronic delays, and the low quality of some transport services. Considering the fact that transport demands are rising steadily, we should not be restricted only to the construction of new infrastructure and opening markets. It is necessary to optimize the transport system so that it meets the requirements for sustainable development. The modern transport system has to be sustainable, in terms of economy, social, and the environmental aspects.

KEY WORDS: transport, sustainable development, environment, means of transport.

1 SUSTAINABLE DEVELOPMENT

Development and its sustainability are issues which gain global dimensions and time urgency. Originally separated issues concerning the development - how to assure a good and safe life for all people on Earth; and sustainability - how to live within the environmental rules and limits, have combined together into one - how should we and our children live on this planet without exceeding the degree of its bearing capacity and limit the ability of future generations (Meadows et al., 1992). The basis of sustainable development is so extensive that there is no single definition which would be able to cover the complexity of the concept, which is reflected in a wide variety of definitions and interpretations. Individual interpretations and approaches to sustainable development differ according to the fact whether they lay emphasis on the environmental, social, or economic perspective. The economic approach emphasizes efficiency, growth, stability, intergenerational equity, and employment. The social approach focuses on poverty, cultural heritage, intergenerational equity, citizens' participation in decision-making processes, and employment. The environmental approach pays attention to biodiversity, natural resources, and environmental pollution.

The concept of sustainable development represents an alternative model of society's development which corresponds with the new situation of the contemporary world, which has radically changed recently. The reflection of the natural environmental limits on economic growth was missing in society before the occurrence of the concept of sustainable development. However, soon after the onset of the Industrial Revolution, the voices of economists and demographers (Mill, 2004, Malthus, Flew, 1983) on the impossibility of unlimited economic growth resounded, particularly when it was connected with population

growth. A new term "global issues" emerged in the 1960s whose urgency was noted in connection with the globalization of human civilization, which created the basis for a consuming society. The term was introduced and then spread, especially in connection with the activity of Club of Rome, which was established in 1968 in Rome and brought together important scientists, cultural, and political personalities, as well as representatives of industry. Theories and methods of this club are based on the assumption that mankind is currently in a critical situation and it is essential to monitor global issues in a complex way, taking the mutual coherence of all parts of the environment into consideration. This development of opinions is contemporarily being developed, particularly in developed countries, towards the improvement of development in this context, and sustainable development represents a new strategy framework for civilization's development in this connection. This approach comes from a report of the UN Commission for the Environment and Development (Bruntland, 1987) that considers such development to be sustainable and which will assure the needs of current generations without compromising the needs of future generations and additionally without being at the expense of other nations. The definition of sustainable development in the Czech legislation is dealt with by the Environmental Act No. 17/1992, as amended, as follows: sustainable development is such development which provides current and future generations with the opportunity to satisfy their basic living needs and does not reduce natural diversity and preserves the functions of the natural ecosystem.

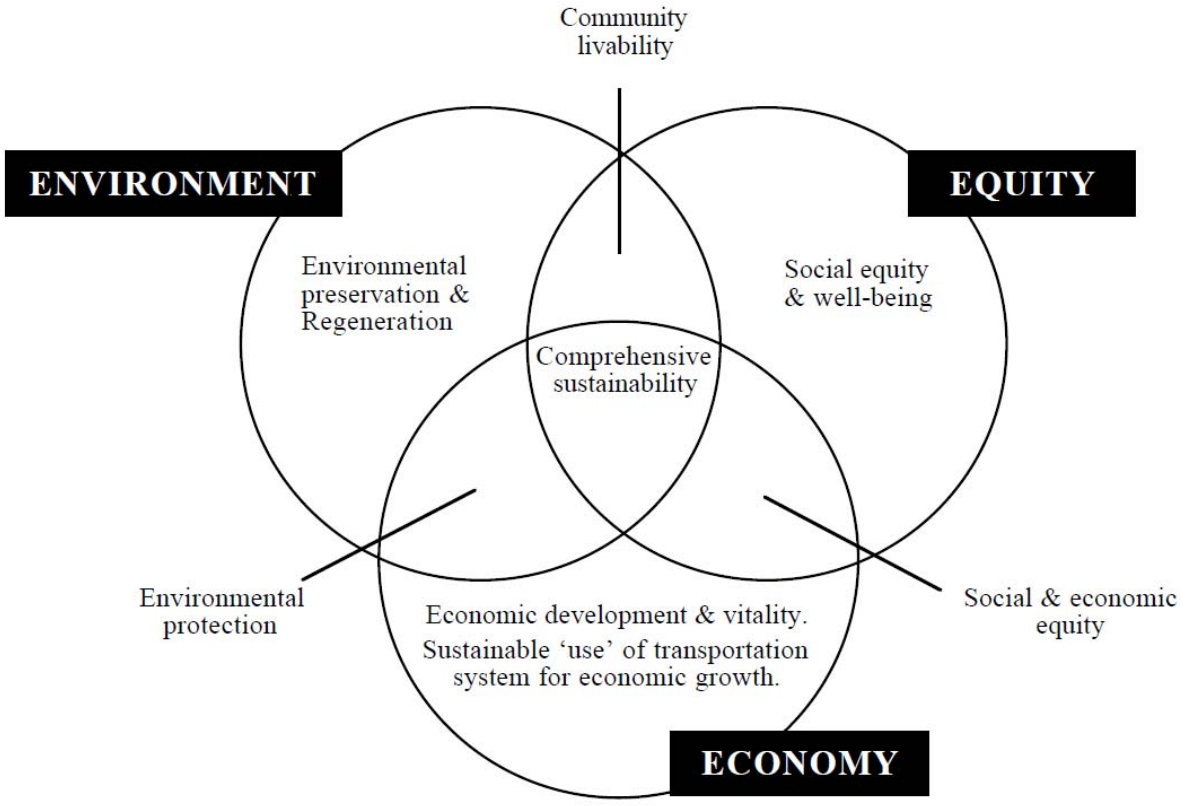

Figure 1: Definition of sustainable transport (Marks, 2002).

The World Summit on Sustainable Development, held in Johannesburg in 2002, pointed out again that it is necessary to promote such development which will assure the balance

between all three basic pillars: social, economic, and the environmental. The conclusions adopted at this summit included the determination of the fundamental principles of sustainable development which are mentioned in Table 1.

Table 1: Basic principles of sustainable development.

Principle	Description
The connection of fundamental areas of life	It concerns three fundamental pillars: economic, social and the environmental.
The long-term perspective	Each decision has to be considered in terms of long-term impacts; they have to be planned strategically.
The capacity of the environment is limited	Considering not only raw material resources, materials, and functions necessary for life, but also space for waste and contamination of all kinds.
Preliminary carefulness	The consequences of some of our actions are not always known because our knowledge patterns operating within the environment are still at a very low level and therefore we have to be careful.
Prevention	Much more effective than consequent removal of impacts; is to invest the funds in the solution of problems before they have occurred than in the subsequent solution for impacts.
Life quality	It does not only include material, but social, ethical, aesthetic, mental, cultural aspects, and others; people have a natural right for a quality life.
Social equity	The opportunities and responsibilities should be divided among countries, regions and various social groups as well.
Considering the relationship "local − global"	The activities at the local level influence problems on a global level − they create them or help them to be solved; it works vice versa as well.
Intra-generational and intergenerational responsibility	The assurance of national, racial, and other inequalities, respecting the rights of all current and future generations for a healthy environment and with social justice.
Democratic processes	The involvement of the public from the initial planning phase.

It was further stated that the basic assumption for the achievement of sustainable development is the so-called "good governance", which means transparency, responsibility, integrity, appropriate management, effective and available services, partnership commitment, and permanent development of public administration institutions. The consideration of all aspects of society development, among which there are economics, society, the environment, and culture, leads to particular decisions which will support sustainable development. Development does not always have to mean only the increase of the material level. However, sustainable development also does not mean the limitation of material needs under a tolerable rate, but it rather deals with value orientation and the lifestyle connected with it.

A significant part of the economic pillar is transport, which, by its activity, concurrently influences the remaining two pillars of sustainable development, both in a positive and negative way. Not only due to this reason, but also in terms of sustainable planning and development, more attention is currently paid to transport.

2 SUSTAINABLE DEVELOPMENT IN THE INTERNATIONAL CONTEXT

The current and planned development in the transport sector aims to reach gradual reduction of negative impacts on the environment and human health by transport infrastructure and traffic operation. The fundamental assumption for this fact is to meet sustainable development principles resulting from international conferences dealing with this issue, national strategic plans of individual resorts, and the Sustainable Development Strategy of the Czech Republic. Among the main international events which currently influence the content and activity focus regarding transport, environment, and health, there is the UN Conference on the Environment and Development, the so-called "Earth Summit", 19th UN General Assembly session, the so-called "Rio+ 5", also known as "Earth Summit II" (1997), the UN Conference on Sustainable Development (2002), the so-called "Earth Summit III", and the annual meetings of the Commission for Sustainable Development (CSD).

The Organization for Economic Cooperation and Development (OECD) is paying more attention to the issues of sustainable development as well. Fundamental documents which should provide an idea to this organization's policy were approved at the regular meeting of the OECD Ministerial Council in May 2001. Sustainable development is marked in the final communiqué as the overarching goal of the governments of OECD countries.

The meeting approved the fundamental political document "Measures to strengthen sustainable development", in which it stated that sustainable development requires a broad concept of human welfare, and focuses on those areas where the most serious risks of unsustainability appear. Among these important areas is primarily the separation of the environmental burden from economic growth. The following goals are identified as crucial (Janic, 2006):

- development of approved indicators which measure the progress in all three dimensions of sustainable development, including the separation of economic growth and the impact on the environment,
- identification of ways in which to overcome obstacles to reform the developing policy, especially the better use of market-oriented tools and a reduction of environmentally harmful subsidies,
- continuation of the social aspect analysis of sustainable development,
- production of guidance for integration and the coherence of economic, social, and environmental areas.

Additionally, the European Union (EU), in the so-called Amsterdam Treaty on the European Union, effective since 1 May 1999, assigns "the balanced and sustainable development" significance comparable to the aim of "economic and social progress". Environmental protection is included in the main goals of the Community in article 2: "high level of air quality protection and improvement". The requirement of environmental aspect integration in other areas, mainly in the economic policy sector, is embedded in article 6. Two important documents have been passed at the international conference in Göteborg (2001):

- Proposal of the 6th Environmental Protection Action Plan with five main objectives (defence against climate change, natural conservation, ensuring a good environment in terms of health protection, protection of natural resources, and waste management).
- "Sustainable Development Strategy of the European Union" with six areas which should be dealt with as priorities: climate change and clean energy, public health, management

of natural resources, poverty and social exclusion, population ageing and demography, mobility, land-use, and urban development.

The EU follows the Lisbon Summit (2000) and joins four other objectives in the environmental and economic area to the two goals of the social field so it completes the overall strategy for the next period. Based on these facts and following the survey of the EU Sustainable Development Strategy, which was initiated by the Commission in 2004 and the Commission statement titled "The Evaluation of Sustainable Development Strategy - Action Platform" in December 2005, the European council adopted the complex renewed strategy of sustainable development for the EU enlargement, and, in June 2006, published the results from the strategy adopted in 2001. The main goals of the renewed strategy are as follows:

- *Environmental protection* - To assure that the Earth is able to maintain life in all its varieties, to maintain the limited quantity of natural resources of the planet and to assure the high level of protection of and improvement of the quality of the environment. To avoid environmental pollution and support its reduction, and support sustainable consumption and production, so that economic growth is not connected with environmental deterioration.
- *Social equity and coherence* - To support democratic, coherent, healthy, safe, and fair society, which supports social integration, maintains fundamental rights and cultural variety, which creates equal opportunities, and which fights against all forms of discrimination.
- *Economic prosperity* - To support the prosperous, innovative, competitive and environmental economy based on a wealth of knowledge which brings high standards of living, and full and quality employment throughout the whole European Union.
- *Meeting the international commitments* - To support the worldwide establishment of democratic institutions based on peace, safety, and freedom, and to defend their stability. Actively support sustainable development throughout the whole world and assure that internal and external policies of the European Union be consistent with global sustainable development and its international commitments.

The major objectives mentioned in the renewed Strategy are elaborated in the “transport” section in the following measures:

- To take measures to improve the economic and environmental performance of all transport modes and take appropriate measures for transferring road transport onto rail and water transport, and the use of public transport; the measures also include a reduction in traffic intensity through the re-organizing of production and logistic processes and a change of behaviour together with the better interconnection of various transport modes.
- To increase energy efficiency in the transport sector using cost-effective instruments. To focus on possible alternatives of freight and passenger road transport, including the development of the Trans-European Transport Network and combine connections for freight transport, e.g. by implementing the measures determined in the Commission action programme for Inland Waterway Transport, titled "NAIADES” and "Marco Polo II” programme.

- To examine the use of infrastructure charging for all types of transport based on new opportunities which are emerging in connection with new satellite information and communication technologies, within the scope of directive 1999/62/EC on charging fees for using certain roads by heavy vehicles. Not later than in 2008, the Commission will submit a generally usable, transparent, and complex model of assessment of all external costs which should be used as a basis for future calculations of the infrastructure charging.
- To strive for effective worldwide solutions, as far as the reduction of negative impact of international naval and air transportation is concerned.
- To reduce the number of deaths in the road transport by half and reduce the number of injured, increase road traffic safety by improving the road infrastructure, increase vehicle safety by promoting joint European-wide awareness campaigns in order to change the behaviour of road users, and through the introduction of cross-border enforcement rights.
- The city authorities should produce and execute the plans and systems of city transport while taking into account the guidelines which were issued by the Commission in 2006 and with consideration of all closer cooperation of cities within adjacent areas, in accordance with the strategy for urban environment.
- To produce a long-term and consistent strategy concerning fuels.

The above-mentioned goals, which were determined by the renewed strategy of sustainable development of the EU, are also being transformed to Strategy for Sustainable Development of the Czech Republic and subsequent strategic and conceptual materials of the individual ministries, such as the Transport Policy for 2005-2013.

3 SUSTAINABLE DEVELOPMENT IN THE CZECH REPUBLIC

Sustainable development started to be applied in the Czech Republic as a modern principle of development after 1989. In the late 1990s three environmental policies in total were produced and adopted, which emphasized the notion of sustainable development. The first strategic material was the so-called "Rainbow programme" of the Ministry of the Environment in 1990, which considered the principle of sustainable development to be one of the fundamental ones. The preparation and approval of the first generation of the environmental legislation (including Acts on waste, air pollution, nature and landscape conservation, and environmental impact assessment) were its main features. The new legal regulations focused on reaching the highest possible increase in environmental status within the shortest possible time and comprised of the whole range of "transformation elements" (e.g. a very strict regime of cross-border movement of waste). The existing or newly established institutions of public administration (especially the Ministry of the Environment and the Czech Environmental Inspection) and supporting institutions (e.g. the State Environmental Fund, the Czech Environmental Institution) were transformed or newly established together with legislation. The "revolutionary" Rainbow programme was replaced with the "State Environmental Policy" in 1995, which was an apparent step backwards. It omitted a range of modern demands on environmental protection (e.g. the integration of environmental demands in the other sector policies) and it was exceedingly determined by blind technocratic economism of that time. This policy utterly omitted the principle of sustainable development explicitly; however, it stood for the basic

requirements of intra-generation responsibility (Třebický et al., 2001). The new State Environmental Policy, compatible with environmental policy of European Communities, which considers sustainable development to be its basic starting point, was adopted in 2000 (and amended in 2001). The Government of the Czech Republic approved or took into account some sector policies in the course of 1997 – 2000, which stood for the sustainable development principles to a greater or lesser extent. In its Programme statement the government even states that sustainable development is considered to be one of its fundamental objectives. However, it was apparent that by 2002 no fundamental document had managed to address the issue of sustainable development across the required range. In 2002, a team of authors from Charles University Environment Centre in Prague produced a proposal for a national strategy for the sustainable development of the Czech Republic. This document had the goal to fill in the existing absence of concise and sufficiently complex material, which would contribute to a desirable transformation of the social and economic development of the Czech Republic in the interests of its sustainability.

In spite of this very progressive document, it took another two years, until 8 December 2004, when the Strategy for Sustainable Development of the Czech Republic (SUR) was approved by government resolution number 1242. The fundamental goal of this strategic document was to point out the existing and potential problems which could threaten the transition of the Czech Republic towards sustainable development, and initiate the measures to avoid or at least mitigate these threats. SUR ČR has become a fundamental document for the processing of other conceptual materials, such as sector policies, as well as action plans. The strategy defines the main objectives, further sub-goals, and instruments. The main objectives are based on three pillars - economic, environmental, and social and they are accompanied by four other areas - research and development, education, European and international context and, last but not least, the governance of public issues. The proposed objectives lead to a guarantee of the highest possible life quality for current generations and to ensure the quality life of future generations. The basic time framework of SUR is 2014, however, some considerations and objectives will take until 2030.

The document "Renewed Strategy for the Sustainable Development of the Czech Republic", which results from principles mentioned in the original Strategy, and specifies some of their starting points, was published in May 2007. The renewed strategy is divided into twelve areas, which are based on the six original ones mentioned in the text; however, they make them more explicit and complete, especially considering the renewed SUR of the European Union. The determination of objectives within twelve fields is made with regard to the basic idea of sustainable development, which looks for harmony between the three basic pillars. This strategy is further completed with three cross-sections, which are life quality and freedom of choice, development and the maintenance of the Czech landscape, and the separation of development curves of economic performance from the impact on the environment. SUR completes these fields with approaches which exceed and integrate the individual areas and pillars at the same time.

Work on updating SUR ČR led to the production of the document "Strategic Framework for the Sustainable Development of the Czech Republic" (SRUR) which was approved on 11 January 2010 by the Government Resolution No. 37.

This document is of an all-resort cross-sectional nature. SRUR informs the government authorities and summarizes the general level of key topics, problems, and possible solutions. Its objective is not to save specific measures or replace the resort or cross-sectional strategies, but to support their long-term orientation and mutual interconnection. The time horizon of SRUR is 2030. An important task is to prepare a text about sustainable development within the implementation of the SUR text on sustainable development which will contain

the binding tasks, verifiable targets, and, especially, the binding decisions and verifiable cost estimates and impacts. SRUR priorities and objectives are classified into five priority axes; the structure is shown in Table 2.

Table 2: SRUR priorities and objectives.

Priority axis 1: Society, people and health	**Priority axis 2: Economy and innovation**	**Priority axis 3: Land use development**	**Priority axis 4: Landscape, ecosystems and biodiversity**	**Priority axis 5: A stable and secure society**
Priority 1.1: Improving the conditions for healthy lifestyle	Priority 2.1: Supporting the dynamics of the national economy and improving competitiveness (in industry and business, agriculture, services)	Priority 3.1: Fostering territorial cohesion	Priority 4.1: Landscape conservation as a prerequisite for biodiversity conservation	Priority 5.1: Fostering social stability and cohesion
Priority 1.2: Improving the lifestyle and the health status of the population	Priority 2.2: Ensuring national energy security and improving the energy and raw material intensity of the economy	Priority 3.2: Improving the quality of life of the population	Priority 4.2: Responsible farming and forestry	Priority 5.2: Efficient country, good governance and civil sector development
Priority 1.3: Adjusting policies and services to demographic development and fostering inter-generational and family cohesion	Priority 2.3: Promoting human resources development, supporting education, research and development	Priority 3.3: Promoting strategic and land-use planning more efficiently	Priority 4.3: Adaptation to climate change	Priority 5.3: Improving the preparedness to cope with the impacts of global and other security threats and risks and strengthening international links

Each of the priorities is further elaborated into individual goals which deal with the assumptions of meeting the priorities in greater detail. The objective of the Strategic Framework for the Sustainable Development of the Czech Republic is to create the consensual framework for the production of further materials of a conceptual nature, such as sector strategies, policies or action plans, and are thus an important basis for strategic decision-making processes within the individual resorts, regions, cities and communities, for inter-resort cooperation, as well as for the cooperation of non-interest groups.

The assurance for the effective implementation of SRUR ČR is implemented in three fundamental steps:

1. Production of methodological recommendations for the strategic document preparation at the national level resulting from the principles of strategic planning and containing certain aspects (i) of priority and goal integration of the SRUR ČR in the appropriate resort strategic documents (newly being established or updated), evaluation of resort programmes compliance and plans with priorities and the goals of the SRUR ČR,
2. Providing additional necessary methodology consultations, instructions, and other help for ministries, regions, local authorities, and other partners of the SRUR ČR,
3. Introduction of a complex monitoring system for the implementation of the SRUR ČR by using of the existing information systems, indicators, and available data resources.

4 INDICATORS OF SUSTAINABLE DEVELOPMENT

It is necessary to determine the indicators which are used as an information system that shows the degree of development sustainability or unsustainability for a perception of the wide term of sustainable development, so that it can be used as a specific argument in desussions about development characteristics. The sustainable development strategy is a process of continuously seeking consensus between various interests whose success needs to be continuously evaluated, and to implement the information received in the decision-making process retroactively (Moldan, 2001), which means finding and defining indicators with a reasonable degree of explanatory power about the fact whether an agreed goal succeeds or fails. The indicators should meet some requirements among which are included: representativeness, real identifiability, simplicity and comprehension, price availability, and efficiency, in order to be really practically applicable. The last two requirements lead to the formulation of an indicator set which respects the well-known principle during the decision-making process "to make do with the minimum of available evidence".

One of the basic attributes of the indicators is an addressee or information receiver which is brought by the indicator itself. This pragmatic aspect states that to construct and measure any indicator is only worth doing when we can identify the individual or institution which is able or willing to use the acquired information in its decision-making process. (Moldan, 2001) All activities connected with the SUR ČR creation and updating production of situation reports with the evaluated indicator set and methodical coordination of conceptual documentation are provided by the Government Council for Sustainable Development and its working groups.

The Council is formed by central authority representatives of state administration, municipal authorities, social partners, academia, and the non-profit sector. The state of individual areas of sustainable development in the Czech Republic and the evaluation of meeting the SUR targets is being monitored by a set of indicators constructed on the basis of official data and verified methods, and the results are regularly published in the situation reports of the Strategy for the Sustainable Development of the Czech Republic, which is approved by the government. The existing indicators (ČSÚ, EUROSTAT, OECD, UN Commission for Sustainable Development) are within SRUR used to a maximum extent, so that their development over time (time series) can be followed. The indicators are designed for the individual priority axes and their overview is mentioned below.

Table 3: SRUR indicators.

0.A Ecological footprint				
Priority axis 1: Society, people and health	**Priority axis 2: Economy and innovation**	**Priority axis 3: Land use development**	**Priority axis 4: Landscape, ecosystems and biodiversity**	**Priority axis 5: A stable and secure society**
I.A Standardized mortality rate by disease groups I.B Population exposure to suspended particulate matter I.C Life expectancy and healthy life expectancy I.D Emissions, mineral extraction and biomass production which are associated with household consumption I.E Households' debt I.F The employment rate of older workers I.G The old-age index and the dependency index	II.A GDP per capita II.B Labour productivity II.C General unemployment rate II.D Transport density II.E Energy intensity of GDP II.F Consumption of primary energy sources II.G The proportion of energy from renewable sources II.H Material consumption II.I Surface water and groundwater extraction by sector II.J Waste management according to the main management methods II.K Education level structure II.L Expenditure on research and development II.M Access to the Internet	III.A GDP per capita III.B General unemployment rate III.C Expenditure on research and development and the number of employees in research and development III.D Municipalities that are involved implementing the local Agenda 21 method III.E Migration balance of rural communities III.F Revenue per capita and debt service III.G Passenger transport by public road and rail transport III.H Access to the Internet III.I The number of people in shared accommodation establishments III.J Public budget expenditure on culture III.K The coverage of the territory with approved land-use planning documents of municipalities III.L Proportion of built-up areas in the total area	IV.A The indicator of changes in the territory and ecosystems IV.B Index of common species of wild birds IV.C Expenditure on environmental protection and public expenditure on environmental protection IV.D Consumption of basic nutrients in mineral fertilizers IV.E The proportion of organic farming IV.F Deforestation IV.G The intensity of logging	V.A Corruption perception index V.B Participation in election V.C The population living below the poverty line before and after social transfers V.D General government balance and debt V.E The average length of judicial proceedings V.F Total international development cooperation V.G Greenhouse gas emissions per capita and per unit of GDP V.H Foreign direct investment

5 SUSTAINABLE TRANSPORT

Transport is one of the crucial areas of the Czech economy with considerable significance for international relations. The transport passenger and freight demand rises steadily and it is necessary to create legal and economic conditions for providing public services in transport and to provide the infrastructure corresponding with the growth in transport needs (Adamec et al., 2005). Sustainable transport can be defined as services which create conditions for passenger and freight transport, which, on the one hand, is functional, safe, and economic, and on the other hand, is not in contrast with the sustainable consumption of natural resources, decreases the impact on the environment and eliminates the negative impacts on human health (Kušková, 2003). The effort to address this problem in the Czech Republic and its focus on sustainability has to be focused in two directions. Transport system optimization and the promotion of the sustainable transport principles in the society is the first one. The aim of this strategy is to achieve effective and optimum passenger and freight transport, a lower use of motor vehicles, a higher use of urban public transport, and a better capacity use of vehicles and non-motorized means of transport. The promotion of higher eco-efficiency for the means of transport, especially cars, is the second task. This means not only to continue to increase of the efficiency of engines and improving the effectiveness of the catalytic systems for capturing the emissions of combustion engines, but also to introduce and promote alternative types of fuel, to be common and affordable for the standard user. The development of transport and transport systems is long-planned and implemented through transport policies in individual countries. The general objective of the sustainable transport policy is to create conditions for meeting the sustainable transport development in a way which is defined above. It is apparent that meeting such objective is a difficult task - traffic considerably influences the economic, social, and environmental dimensions of life, is deeply rooted in the majority of major components of society, and its extensive development is can only be changed with great difficulties in most countries.

The issue of sustainable development is also defined in the SRUR ČR, in priority axis 2 - Economics and innovation priority, 2.1- Supporting the dynamics of the national economy and improving competitiveness (in industry and business, agriculture, services), Objective 4 - Improving transport quality, efficiency and safety. The goal comes from the needs laid on transport sustainability, the reduction of emissions including noise, and the increase in the energy efficiency of transport. It is necessary to complete the basic network infrastructure of railway and road transport (network TEN-T and important linked routes of national and regional importance) and to construct the missing safety infrastructure for bicycle transport. Likewise, it is necessary to support the implementation of traffic engineering and traffic organizational measures, both for transit traffic exclusion from populated areas, or to increase the road traffic flow in general (for a considerable reduction of pollutant emissions and carbon dioxide). Construction has to be implemented with limited negative impact on important localities concerning the natural value, the fragmentation of landscape, and its migratory conditions. It is also necessary to modernize railway transport and control its function as a backbone transport network in terms of freight and passenger transport, considering the lower external losses. Furthermore, to enhance energy efficiency and the economic efficiency of transport, reduce emissions from transport and prepare for the oil peak. It is necessary to support public transport and the terminal networks of multi-modal transportation, including multi-modal public logistics centres based mainly on rail transport. It is necessary to provide quality transport services and to enhance traffic safety and introduce telematics applications in all transport modes. An important goal is also to introduce an appropriate system of price determination for using the transport infrastructure and to internalize external losses in transport prices.

6 INDICATORS OF SUSTAINABLE TRANSPORT DEVELOPMENT

Transport importance in the sustainable development of the Czech Republic is reflected by the SUR ČR and the SRUR ČR, where the selected transport indicators are part of a set of indicators used for the regular monitoring of meeting the determined objectives.

Table 4: Strategic objectives of the SUR.

Strategic objectives	Indicators
Separation of economic growth and demand for transport in order to reduce negative impacts.	Transport in freight transport.
	Number of public logistics centres.
	The rate achieved by internalization of the external damage of individual transport modes expressed as a percentage of the total external damage, furthermore absolute value expressed in CZK and a price share according to the EU schedule in 2009 (on the basis of methodology adopted by the EU).
Achieving sustainable levels of using energy in transport and a reduction in emissions of greenhouse gases from transport.	Greenhouse gas emissions from transport divided into fossil sources and sources from the biomass.
	The consumption of individual fuels (tonne/year).
	Air transport emissions (person and kilometre).
	Number of CNG filling stations.
	Number of vehicles running on CNG.
	increase the energy efficiency of transport through technological modernization and logistics.
	Carbon dioxide emissions from motor vehicles in the Czech Republic.
The reduction of transport pollutant emissions to levels which minimize possible influence on human health or the environment.	Transport share on total air pollution (%).
	The overall transport emissions (PM10, PAH, NO_x, NO_2, VOC, benzene, SO_2, CO, CO_2, some metals and PM2,5 – overview).
	emissions of the individual means of transport (per t km, person km).
Improvement of safety.	The development of accident rates (number of deaths, injured with apallic syndrome, i.e. irreversible diffuse damage of cerebral cortex, the severely injured, material damage).
	Number of deaths, slightly or seriously injured people in traffic accidents.
	Number of accidents with hazardous cargo.
Achieving the appropriate modal split according to the co-modality principle.	Number of km of road with performance charging (km).
	The share of transported performance of road freight in comparison to railway and water freight transport (%).
	The share of railway transport on transport performance (%).

The area of transport is represented in SRUR ČR by two indicators in Priority axis 2: Economics and innovations, by indicator II.D Transport intensity and in Priority axis 3: Land

use development, by indicator III.G Public passenger transport by road and railway. The indicator II.D Transport intensity is defined as the ratio of traffic volumes and GDP (person/km per CZK 1000, tkm per CZK 1000) and it is used for assessing whether it comes to trends in GDP and transported operation. This separation is desirable because the significant effects on the environment are connected with transport performance as well. The indicator III.G Public passenger transport by road and railway is defined as the number of trips by railway and public bus transport realized by one inhabitant of the region (number per capita). The indicator significance lies in the fact that the reduced transport services of the regions cause problems in commuting to work, as well as services. Public transport has lower environmental impacts than car transport and has a crucial importance in increasing transport services.

In the gradual updating of the SUR a definition of clear goals appears where the aim for transport should be within the Czech Republic and these objectives are specified by other indicators which determine the meeting of these strategic goals.

7 SUMMARY

Regarding the above mentioned information it is apparent that the issue of sustainable development and sustainable transport is very broad, complex, and complicated. In spite of this, it is necessary to realize that increasing mobility does not only have a positive contribution to the society, but it also brings a large amount of negative impacts which we should try to prevent. Experience, however, points towards a clear instruction that sustainable development is impossible without an adequate economic policy. The task will remain to produce the sustainable transport development strategy in accordance with international recommendations which would satisfy the needs of current generations without being an unbearable burden for future generations. The indispensable part of the strategy is also a set of indicators which will be used for the monitoring the implementation of individual strategic objectives and a subsequent comparison of development on the international level, which will enable the possible revision of the designed measures for the sustainable development of transport.

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Legislation Framework

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ABSTRACT: The mentioned legal regulations determine the basic terms and determine the fundamental principles of protection of the environment and the duties of natural persons and legal entities in the protection and improvement of the condition of the environment and in the use of natural resources; nevertheless, it is absed on the principle of sustainable development. The right conception of the legislative framework, which deals with the protection of the environment in a complex way, could contribute considerably to the improvement of the conditions of the environment.

KEY WORDS: legislation, regulation, law.

1 THE EUROPEAN UNION LEGISLATION TOOLS FOR THE PROTECTION OF THE ENVIRONMENT AGAINST TRAFFIC IMPACTS

Legal protection of the environment has undergone dynamic development since the beginning of European integration. Environmental protection is, within the EU, regulated by mandatory and non-mandatory mechanisms. The basis of the mandatory regulation is a Treaty of the European Community (TEC, The Treaty of Rome), which has been amended four times - by The Single European Act, The Treaty on the European Union (Maastricht Treaty), The Amsterdam Treaty, and The Treaty of Nice. The law of the European Community (EC) is a special type of law, and its operation is defined according to Article 3b of The Treaty of Rome "through limits of entrusted competences and goals, which were determined by it". The environmental protection is included. Its Article 6the requires that the environmental protection be integrated in all EC policies with an emphasis on sustainable development. The majority of the specific standards adopted for the environmental protection are based on Article 95 harmonizing the regulations to create an inner market and Articles 174 – 176, which are the crucial legal basis for the environmental measures. The provisions of the Treaty of Rome cannot be applied directly. It is necessary to specify them in so-called secondary sources of the environmental law. The majority of provisions of the environmental Community law are included in regulations, directives, and decisions of the European Parliament, Council, and Commission. The legal regulation, which would be focused

on a solution of the environmental issue in the EC in a complex way, has not been drafted so far (Kružíková et al., 2003).

The fundamental principles of the environmental law of the EC (Ball et al., 1998) are:

Principle of prevention: generally the most important, as far as environmental protection is concerned. The environmental policy of all countries is based on it. It has a crucial role in legal regulations. Prevention is less expensive and more efficient than consequent remedy actions.

Principle of subsidiarity: concerns the division of the relationship between competences and the individual management levels. Subsidiarity means that competence should be placed on the lowest possible level of the decision-making process, which is closest to the specific problem and the citizens. The principle of subsidiarity is common for all the coordinated policies of the EC. According to the subsidiarity principle, the EC should only become active when the member states may not interfere on their own in the same effective way. In the environmental policy the use of this principle is limited, because a range of environmental issues do not respect state boundaries (typically air pollution). Therefore, mostly the regulation at the level of the EC is more effective.

Principle of a high level of protection: adopting the European legal standards should be based on the traditions of "the stricter" member states and the latest technologies and methods of protection. The EC standard could be "softer" than it is in the strictest state of the EU. The individual states may maintain their higher standards. This principle is also used to "export" national environmental legislation from more demanding states of the EU to other member states, and it restricts the "unfair competition" of states with softer demands on the environmental protection.

Principle of "polluter pays": the economic expenditures on the removal of pollution in the environment should not be paid by the whole society, but by the specific polluters. It deals with an effort to internalize the externalities. This principle requires that the polluter takes responsibility for the external expenditures which are produced as a consequence of their pollution activities.

Principle of protection as close to the pollution source as possible: the environmental damage should be prevented as close to the place of origin as possible, and not at other stages of the pollution chain. An example is the effort to deal with dangerous waste as close to its producer as possible, and not at distant processing facilities (the number of risks connected with the handling and transport decreases).

Principle of sustainable development: was defined as "development which meets the present needs without compromising the ability of future generations to meet their own needs" as far as economic, social, and environmental needs are concerned. It has become a general principle of the environmental protection in the member states on the basis of the Maastricht Treaty.

Principle of integrated protection: all possible effects on the environment have to be taken into consideration. It is not possible to follow only one aspect of protection and omit the others. In a broader sense this means that the impacts on the environment have to be taken into account also when proposing and executing other EC policies (such as industrial policy,

the consumer protection policy, transport policy, trans-European networks). The principle of integrated protection is considered to be the most important principle of the environmental protection in EC.

The EU' s non-mandatory activities particularly include documents of these types:

- Action plans for the environmental protection (the 6th Action Plan for 2001 – 2010 is now in progress and links the key principles of sustainable development from the 5th Action Plan).
- Recommendations, specific measures, and standpoints (e.g. the “Green Paper - Towards fairer and more effective prices in transport", or the “White Paper - European transport policy for 2010: time to decide").
- financing the individual programmes from the EC funds (Cohesion fund and funds specializing in the environment - example.g. LIVE, SAVE, ALTERNER).

Environmental law is divided into two main categories:

a) horizontal (cross-sectional) regulations which determine the institutions, instruments, and principles common for the whole area of the environment

   - integrated prevention and limiting the environmental pollution
   - assessing the influence on the environment (EIA)
   - free access to information on the environment
   - system of environmental management and audit (EMAS)

b) regulations for the protection of environmental components or sources of pollution

   - air, water, nature
   - noise caused by motor vehicles, machines, and devices
   - waste

The legal standards adjusting the sanctions are still not a part of the system of the Community environmental law so far. Considering the fact that member states are obliged to assure the effective application of regulations in their own legislation, they have to set the sanctions for violating their provisions, which have become a part of their legislation. It is up to each state which sanctions are used. However, they have to be appropriate and correspond with the sanctions imposed in similar cases of violations of national standards.

Currently, 350 - 500 legal standards concerning the environment are effective in the EU. The European Union issues all agenda in the Official Journal of EU documents (similar to our Collection of Laws) and on CD-ROM. The LEGISLATION database is analytically structured in 20 sections (the most important sections for transport departments are: Section 7 Transport policy and 15 The environment, consumers and health protection). The adoption of directives, regulations, and decisions are mandatory for the EU member states and they are subsequently adopted by regulations at national levels.

The Convention on Long-range Trans-boundary Air Pollution and related protocols have the widest effect of the mandatory regulations of the European states connected with the influences of transport on the environment. The fundamental principles of The Convention include the fact that the signatory powers will protect mankind

and their environment, and they will try to restrict, gradually reduce, and prevent air pollution. The Convention has become a basis for issuing other protocols on the restriction of emissions of individual pollutants. The most advanced instrument of The Convention - Protocol AcETO is focused specifically on the reduction of the effects of air pollution in Europe, and it is a fundamental document of the cross-sectional category of the EU. Its goal is emission control and the reduction of sulphur, nitrogen oxides, ammonia, and liquid organic components produced by human activity and unfavourably affecting health, natural ecosystems, materials, and agricultural plants as a consequence of acidification, eutrophication, and ground-level ozone. The specific individual national emission limits, which should be reached by 2010, are the main tools to meet the AcETO protocol targets. the EU, under its former name of the European Community (EC), has committed to meeting The Convention and a range of other subsequent protocols with its signature and ratification as one of the member parties. On the basis of this act the EU then gradually takes over the individual protocols of the European economic commission of the UN and issues them as individual mandatory directives, which are further elaborated in a range of relevant regulations and recommendations in greater detail.

The legislative environmental measures for transport contain regulations dealing with the protection of environmental components or the sources of pollution. The regulations for air protection which determine the maximum acceptable contents of particular pollutants in exhaust gases and the values for the quality of fuel are used. The legislative measures which regulate noise and waste from transport are equally important.

The first regulation for pollutants in exhaust gases in Europe was the directive of the United Nations Economic Commission for Europe No. 15 (hereinafter ECE 15) which was introduced for passenger cars in 1971. In the late 1980s it was replaced with the regulation ECE 83 which is a basis for valid regulations nowadays. So far it has been amended several times as a consequence of the increasing requirements on the reduction of exhaust gases; and the same applies for the regulation ECE 49 for heavy vehicles with weight over 3.5 tones. The EU issues the equivalent regulations, marked as EURO, to join the regulations ECE 49 and 83.

Although exhaust gases represent a mixture consisting of more than 100 pollutants, the regulations for exhaust emissions only limit carbon monoxide (CO), nitrogen oxides (NO_x), the sum of hydrocarbons (HC), and particulate matter - PM. PM are only limited at diesel engines because their quantity and size is much higher when compared to petrol engines. The emissions of hydrocarbons and nitrogen oxides were expressed as a sum of HC and NO_x in some older legislative regulations.

The production, or the import of vehicles which do not meet the stricter demands, have to finish at the beginning of the validity of a new regulation. In the case of selling new vehicles, the selling of vehicles has to be terminated within one year from the commencement date of the regulation. Further stricter regulations of emission limits under the name EURO 5 came into force in 2008. Only the vehicles of a high technological standard equipped with electronic management of the combustion process and systems which adjust the composition of exhaust gases can satisfy the new stricter limits. The EC legislation deals with the approval of not only newly produced models of cars, but it also controls the vehicle parameters in common production.

The emission limits for heavy vehicles and buses are specified in g. kWh^{-1}. The emission values in $kg.km^{-1}$ (Adamec et al., 2003) can be obtained through a simple calculation with the known average engine performance [kW] under specific conditions and vehicle speed [$km.h^{-1}$]. The stricter emission limits will require a range of construction changes and adjustments on heavy vehicles and buses in the future, as well as in the case of passenger and light commercial vehicles. The emissions of particulate matter are most important

for the cars with diesel engines because they represent a high carcinogenic risk for the health of the population.

The maximum permissible contents of carbon monoxide (CO) and the sum of hydrocarbons (HC) are determined in order to execute control measurements of the emissions of diesel engine vehicles. The content of CO is measured in volume %, the content of HC in mg.kg-1 (or ppm). Each vehicle in its regular inspection (Vehicle Testing Station - STK), which is executed at the measurement emission stations every two years, has to meet these limits.

Not only the type of the combustion engine and technical condition of the vehicle decide on the composition and quantity of exhaust emissions, but so do the type and quality of fuel. The development of fuel quality for combustion engines is influenced considerably by stricter air quality requirements. The most important European regulation concerning fuel quality is the Directive 98/70/EC which has determined the maximum permissible content of lead, sulphur, benzene, aromatics, olefins, and oxygen in petrol and diesel since the beginning of 2000, with further stricter regulation since 2005.

The other environmental instruments, whose international regulations are to be mentioned having a close relationship to traffic and determining the limits of noise levels, are shown in the following Table 1.

Table 1: Noise regulations ECE.

Number of regulation ECE	Name, content of regulation
9	External noise 3-wheel vehicles of the L category
41	External noise of motorcycles – vehicles of the L category
51	Noise levels of vehicles with a minimum of 4 wheels
63	External noise of mopeds – vehicles of the L category

The reduction of the unfavourable effect of environmental noise in the EU, as well as noise from traffic, is an objective of the 2002/49/EC directive on the evaluation and management of noise in the external environment. This directive is in the implementation process in a number of the EU states.

2 LEGISLATION REFLECTING THE TRAFFIC RELATION TO THE ENVIRONMENT IN THE CZECH REPUBLIC

The harmonization of legal regulations in the Czech Republic with the corresponding directives of the European Community was a fundamental requirement for the accression of the Czech Republic to the EU. For all the EU member states the directives, regulations, and decisions are mandatory and they have to be subsequently adopted by Acts and regulations at national levels. The harmonization demands were, in the area of transport, emphasized by the specific nature of transport processes in the Czech Republic, with its high share of international and transit transport. The partial solutions and adjustments of relations of transport to the environment are mentioned in a number of Acts, decrees, and standards in the Czech Republic. The appropriate legal tools of the Czech legislation for the individual transport domains are mentioned for illustration.

2.1 Exhaust emission limits

Act No. 56/2001 , Sb., on road traffic rules. The Decree of the Ministry of Transport No. 302/2002, Sb., on regular technical examinations and emission measurements of vehicles, as amended by the decree MT No. 99/2003, Sb.,.

The Decree No. 341/2002 , Sb., on the approval of technical capability and technical conditions of vehicle operation on road, which superseded the Decree of the Ministry of Transport No. 301/2002, Sb., on the approval of vehicle technical capability.

2.2 Fuel quality

The Decree MPO No. 227/2001, Sb., and the Decree MPO No. 229/2004 , Sb., determine the maximum permissible contents of lead, sulphur, benzene, aromatics, olefins, and oxygen in petrol and diresel (transposing the Directive 98/70 EC into the Czech legislation).

2.3 The relation between emission limits from transport and the air protection legislation

Act No. 472/2005, Sb., which amends Act No. 86/2002, Sb., on air protection and amends other Acts as well.

Government Decree No. 597/2006, Sb., which determines the pollution limits and conditions and procedures of the monitoring, assessment, evaluation, and management of air quality.

Government Decree No. 351/2002, Sb., which determines the mandatory emission limits for certain atmospheric pollutants and the methods of preparation and implementation of the emission inspections and emission projects.

Ministry of Environment Decree No. 355/2002, Sb., which determines the emission limits and other conditions for stationary sources of air pollution which emit volatile organic substances from the processes of applying solvents and from petrol storage and distribution.

Ministry of Environment Decree No. 356/2002, Sb., which determines the list of pollutants, general emission limits, methods of submitting reports and information, detection of quantity of released pollutants, thickness of smoke, admissible level and intensity of irritating smell, conditions for the authorization of people, requirements for maintaining the operational registration of air pollution sources, and the conditions of their application.

Ministry Decree No. 357/2002, Sb., which determines the quality requirements for fuels in terms of air protection.

Ministry Decree No. 358/200 , Sb., which determines the conditions for the protection of the ozone layer.

2.4 Noise pollution and vibrations

Act No. 258/2000 , Sb., on public health and amendments of some related Acts, regulates the rights and obligations of natural persons and legal entities in the field of protection and support of the public health and public health authorities, their powers and authority, which imposes obligations on all operators and administrators of the noise source in order not to exceed the highest permissible levels of noise in the environment.

The Government Enactment 148/2006, Sb., on health protection from unfavourable noise and vibration effects regulates the pollutant limits of noise and vibration.

The transposition of Directive 2002/49/EC on the evaluation and management of noise in the external environment has already been made in the Czech Republic as follows:

The directive in question was implemented in the Czech legislation in June 2006 in the form of an indirect amendment of the Act No. 258/2000, Sb., on the protection

of public health and a change of amendment of related Act as amended. The indirect amendment was realized by Act No. 222/2006, Sb., which changes Act No. 76/2002, Sb., on the integrated prevention and restriction of pollution, the integrated pollution register, and the amendment of some other Acts (Act on integrated prevention), as amended, and certain other Acts.

The obligations imposed by Directive 2002/49/EC are included in Act No. 258/2000, Sb. The Act itself is then implemented in the regulation from November 2006 which is the Decree of the Ministry of Health No. 523/2006, Sb.,, which will determine the limit values of noise indicators, their calculation, basic content requirements of strategic noise maps and action plans, and the participation conditions of the public in their preparation (Decree on noise mapping).

2.5 Waste from transport

Act No. 106/2005, Sb., which takes over the full version of Act No. 185/200 , Sb., on waste, as amended, deals with the car wrecks issue and the obligation of the collection of oil, tyres, and batteries.

The Decree No. 41/2005, Sb., changes the Decree 383/2001, Sb., in details of waste hadnling, regulates the technological requirements for handling car wrecks.

The Decree No. 503/2004, Sb., amends the Ministry of Environment Decree No. 381/2001, Sb., determines the Waste Catalogue, the list of dangerous waste, and list of waste and states engaged in waste export, import and transit and the procedure of approving waste import, export and transit (Waste Catalogue).

The Decree No. 505/2004 from 10 September 2004, which amends the Ministry of Environment Decree No. 237/2002, Sb., on the method of collection of some products.

Transposition of Directive of European Parliament and Council 2000/53/EC on vehicles with expired life span.

2.6 Tax regulations in the field of transport and the environment

Act No. 353/2003, Sb., on excise duties determines the excise duty rates for hydrocarbon fuels and lubricants in accordance with the determination of the minimum rates mentioned in the Council Directive 2003/96/EC.

Road tax is dealt with by Act No. 246/2008, Sb., which amends the Act No. 16/1993, Sb., on road tax, as amended.

Act No. 13/1997, Sb., on roads, as amended, deals with the fees for the use of motorways and dual carriageways. The list of motorways and dual carriageways sections, whose use is subjected to charging, is mentioned in the Decree No. 367/2001, Sb. The amount of fees (vouchers) is given by Government Decree No. 287/2003, Sb., according to vehicle type.

Act No. 235/2004, Sb., on value added tax determines the value added tax and cancels not only the original Act on VAT and all its amendments, but it has changed a range of other Acts as well (e.g. Act on excise taxes, property evaluation, etc.).

2.7 Environmental education and awareness

Act No. 123/1998, Sb., on the right to obtain environmental information, as amended by Act No. 6/2005, Sb. The Government Decree of the Czech Republic No. 1048 from 2000, about the State Programme of Environmental Education and Awareness in the Czech Republic (SP EVVO ČR).

Transposition of Directive 90/313/EHS on the freedom of access to environmental information.

3 SUMMARY

The legal regulations mentioned in the chapter define the basic concepts and provide the fundamental principles of environmental protection and the obligations of the natural persons and legal entities in the protection and improvement of the environment, and in the use of natural resources, while resulting from the principle of sustainable development. The right conception for legislative framework which deals with environmental protection in a complex way could considerably contribute to the improvement of our environment.

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Transport Research

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ABSTRACT: Transport and transport research are significant carriers of economic activities. They play a crucial role in the assurance of sustainable development, and the economic and social growth of Europe. The European transport sector needs to be effective, which means creating an appropriate coordination framework and balancing public and private sources for the support of necessary research activities. Therefore, for the realization of scientific research projects in the following period the use of their results in practice will be of essential importance. The possibility of the application of projects of science and research will be, e.g. in the field of prediction of development of individual fields of transport, in the creation and preparation of regulation, legislation frameworks for the development of the transport system, for organizational and other measures in the field of transport safety, in the realization of support of development of new technical and technological solutions leading to reduction of economic costs of the transport process and in the reduction of negative effects of transport on the environment. Regarding transport and urban planning, after the integration of the environmental and social aspects in the research activities,, the new cooperation could further bring a positive impact on the health of people and the environment.

KEY WORDS: research, development, transport, project.

1 INTRODUCTION

The current transport research is of interdisciplinary and international nature with ties to other important research areas. The R&D projects and research plans are important instruments of the transport policy implementation of the European Union and the individual states. The transport policy defined in the White Paper: "Transport policy of the EU for 2010 - time to decide" clearly defined the basic goal of transport research for the subsequent period, which is the support of the sustainable development of passenger and freight transport (European Commission, 2001).

The Czech Republic will, in the transport research area, in the following years focus primarily on the strategic research of complex transport issues, the increasing role of prediction,, and higher participation in the international research. In accordance with the National Transport Policy, the transport research will intensify the international

cooperation in research and development and it will be gradually integrated into the ERA - European Research Area, it will also increase the cooperation on a national level (MD, 2004).

2 CURRENT CONDITIONS OF EU TRANSPORT RESEARCH AND ITS PRIORITIES

The significance of transport for Europe has risen significantly in the last few years. As described by the EU predictions until 2020, passenger and freight transport will increase, and the same trend is also expected in the Eastern part of Europe. Nevertheless, the awareness of the negative transport impact on the environment and health is increasing in the whole EU, thus the need for further research and development in this area is required (ERTRAC, 2004). Therefore, the EU and the individual states create, support, and realize, apart from their national transport policies, a range of additional research programmes and projects which contribute to achieving sustainable long-term transport development (ERTRAC, 2006).

Sustainable transport appears to be one of the priorities regularly included in general research programmes of the EU. The emergence of many-year funding mechanisms of financing the research and development is embedded in the treaty establishing the European Economic Community in 1957 (part 3, section XVIII, article 166). The main tool of financing the EU is the Framework programme system of R&D which has existed since 1984. On 1 January 2007, the 7FP – Seventh Framework Programme was announced, which grants € 54.585 billion (in prices of 2006) for research subsidies, scientific cooperation, and the mobility of scientific workers, covering the period of 2007 – 2013. The Framework Programme for Competitiveness and Innovation (CIP - Competitiveness and Innovation Programme) with its budget of € 3.621 billion (in prices of 2006) is very similar to 7FP in the innovation areas. Finally, the last part of the triangle of education – research - innovations should become EIT – European Institute of Technology in the future, supported by the European Commission. The Initiative for cleaner and better transport in cities (CIVITAS = City-VITAlity-Sustainability) represents an already existing initiative which helps cities to reach a long-term functioning, clean, and energy efficient transport system. This association was established in 2002 as an innovative project and its activities are also supported in the following framework programmes (6FP, 7FP) (CZELO, 2007). The issue of transport and the environment further appears in the programme of European Cooperation in the field of Scientific and Technical Research (COST) which coordinates the national research support in the European countries participating in this programme. Apart from the COST programme, this issue is also dealt with through bilateral international cooperation (e.g. in the Czech Republic it is coordinated by the Ministry of Education, Youth, and Sports within the KONTAKT programme). The international research support lies also in the information exchange between experts from various countries. It is executed both with EU support within the Framework programmes (Marie Curie Programme), and within research networks associating experts and research institutions. An important subject is the association called Infra Eko (IENE - Infra Eco Network Europe), which focuses on solutions for the locality fragmentation caused by the construction and operation of linear transport projects. Another example is the CEI operation - Central European Initiative, within which the working groups of Transport work with the sub-group Environment, and the group which participated in the "EST goes EAST" programme with an objective to improve the environment on a global level (CZELO, 2007). The European Union has also established an overall legal framework for air protection in Europe. The EU is currently revising this legislation in its CAFE programme - Clean Air for Europe. The CAFE programme also brings information on probable air quality development in Europe, and it takes into account the full

effects of all legislation for emission limits and future economic development. The programme is drawn together with the integration of all major European stakeholders, a common basis of knowledge, which will lead to the production of future policy proposals for air quality improvement in Europe. The Assessment and Reliability of the Transport Emission Model project and Inventory Systems (ARTEMIS) were implemented within the EU and their goals are to develop and harmonize the emission model for road, rail, air, and water transport to provide consistent emission estimates on national, international, and regiona, levels. Transport Research Laboratories based in Wokingham in Berkshire in Great Britain were the project coordinators, and 36 organizations from 15 member states of the EU dealing with transport research (ARTEMIS, 2007) take part in this project. ETERG - The European Transport Emissions Review Group was formed within this project. ETERG offers beneficial approaches and methods for data and information transfer "to and from" projects and national representatives.

The projects dealing with research of alternative fuels and their application in practice have an indispensable role. The questionnaire survey between parties concerned within the VIEWLS project – Clear Views on Clean Fuels revealed three major motivating factors influencing the introduction of fuel: firstly, a reduction in greenhouse gas emissions (87%); secondly, diversification of energy sources (77%); and thirdly, a lower dependence on fossil fuels and their import (76%). Financial profit is the least important of all factors (43%). The PREMIA, a completed project, - Effectiveness of measures to accelerate the market introduction of BIOFUELS and HYDROGEN, evaluated the efficiency of the support programme of the introduction of alternative fuels on the EU markets. The subsidies for energy crop used in power supply industry, investment subsidies, loans and subsidies for factories for bio-fuel production and petrol stations, standards in bio-fuel distribution, tax holidays, obligation of petrol stations to sell bio-fuels, and obligation to purchase vehicles running on alternative fuels by public sector institutions are included in the main measures concerning the support of bio-fuels which were found effective according to REFUEL study (Brůhová – Foltýnová, Máca, 2007) These results should be complemented by planning the road ahead for bio-fuels focused on a detailed assessment of the impact of bio-fuel objectives and strategies on the development of the bio-fuel market. The ACCEPTH2 project - Public Acceptance of Hydrogen Transport Technologies, based on the public attention paid to the extensive demonstrable projects of hydrogen buses - followed the public acceptance of hydrogen technologies in transport. A questionnaire survey carried out in 4 cities (Berlin, London, Luxembourg, and Australian Perth) revealed the total unconditional support of the introduction of hydrogen buses on a large scale on the one hand, which, however, is not reflected in the willingness to pay the increased fare in such buses, in spite of the fact that the fee increase was on average only € 0.35 per user (Brůhová – Foltýnová, Máca, 2007). The selected European institutions dealing with transport research and development are mentioned in the following Table 1.

The European Commission also declared its support to approaching the determination of transport infrastructure fees on the basis of marginal social costs in its White Paper on European Transport Policy. Considering this issue, there are several projects, such as a study of the infrastructure in general, characterization of external expenditure by interaction between road users, calculation of traffic accident costs, and expenditure on the environmental damage (environmental externality) which are, supported. Within the MC-ICAM project - Marginal Cost Pricing in Transport - Integrated Conceptual and Applied Model Analysis) the optimal ways of implementation of the effective charging, in which the users bears the full marginal social costs of their activities, were examined. Within the DESIRE project - Development of European Service for Information on Research and Education, two pricing scenario, on the basis of the driven distance were evaluated.

Whereas the traditional charging for the use of the infrastructure (predominantly motorways) could take traffic to lower class roads, the charging based on the driven distance along the whole transport network, seems to be more suitable for demand management. However, we should note that this slightly complicated system brings more problems considering the technology, cost acceptability, and fee collection. Within the UNITE project - Unification of accounts and marginal costs for Transport Efficiency, the calculations of costs on the individual transport modes and methodological improvements and estimates of marginal costs for the main categories of costs and benefits of individual types of passenger and freight transport were made. Based on estimates, the total infrastructure costs for Western Europe acount for approximately 1.5% of GDP, congestion expenses 1%, external costs of traffic accidents 0.5%, air pollution 0.6%, noise 0.3%, and global warming 0.2% of GDP ((Brůhová – Foltýnová, Máca, 2007).

Table 1: Selected European institutions dealing with transport research.

Name of the institution	Country	Name of the institution	Country
Transport Research Laboratories (TRL)	UK	Scientific and Technical University of Lille (USTL)	F
Technical University of Denmark (DTU)	DK	Swedish Environmental Research Institute (IVL)	S
INFRAS AG Forschung (INFRAS)	CH	Swiss Federal Institute of Technology (ETHZ)	CH
Institut National de Recherche sur les Transports et leur Securite (INRETS)	F	Swiss Federal Laboratories for Materials Testing and Research (EMPA)	CH
Technical University Graz (TUG)	A	Technical Research Centre of Finland (VTT)	FIN
Aristotle University Thessaloniki (LAT)	EL	Centrum dopravního výzkumu, v.v.i. (CDV)	CZ
Organisation for Applied Scientific Research (TNO)	NL	TRAFICO Verkehrsplanung (TRAFICO)	A
psi-A Consult (psiA)	A	University of Littoral Cote d'Opale (ULCO)	F
Aeronautical Research Institute of Sweden (FFA)	S	Lund University (LU)	S
AVL List GmbH (AVL)	A	University of Savoy (US)	F
Banestyrelsen	DK	Vlaamse Instelling voor Technologisch Onderzoek (VITO)	B
Bergische Universitat - Gesamthochschule Wuppertal (BUGHW)	D	Fachhochschule Biel (FHB)	CH
Czyste Powietrze Sp (PPW)	PL	RWTUEV Fahrzeug GmbH (RWTUEV)	D
Fraunhofer Gesellschaft, Institut für Atmospharische Umweltforschung (Fhg/IFU)	D	TUEV Automotive	D
Institute for Transport Sciences (KTI)	HU	The Federal Highway Research Institute (BAST)	D

Name of the institution	Country	Name of the institution	Country
National Research Council of Italy (IM)	I	Mariterm	S
Joint Research Centre, European Commission (JRC)	I	Technikum Joanneum (TJ)	A
Paul Scherrer Institute (PSI)	CH	Union Technique de l'Automobile du motocyle et du Cycle (UTAC)	F
Regie Autonome des Transports Parisiens (RATP)	F	Motor Test Centre (MTC)	S
Renault Research Innovation (REGIENOV)	F	Swedish Road and Transport Institute (VTI)	S

Note UK – Great Britain; DK – Denmark; CH – Switzerland; F – France; A – Austria; EL – Greece; NL – the Netherlands; S- Sweden; D – Germany; PL – Poland; HU – Hungary; I – Italy; FIN – Finland; CZ – the Czech Republic; B – Belgium.

Table 2: Selected international projects with CDV participation focused on transport and the environment.

Project	Name
BUGS	Benefits of Urban Green Space
REFUEL	Planning the road ahead for bio-fuels
PLUME	Planning and urban mobility in Europe
COST 341	Habitat Fragmentation due to Transportation Infrastructure
SUTRA	Sustainable urban transportation
COST 351	Water contamination with pollutants contained in road construction layers
COST 633	Particulate matter produced by traffic
EXTRA 2	Euro- methodologies for travel assessment
WALCYNG	How To Enhance Walking And Cycling Instead Of Shorter Car Trips And To Make These Modes Safer
EST goes EAST	Pilot study of border ecologically sensitive area
TITaM	Transport Infrastructure Technologies and Management
ASSET	Assessing Sensitiveness to Transport
SPENS	Sustainable Pavements for European New member States
CERTAIN	Central European Research in Transport
ARCHES	Assessment and Rehabilitation of Central European Highway Structures
Re-road	End of life strategies of asphalt pavements
ECRPD	Energy Conservation in Road Pavement Design, Maintenance and Utilization
SARTRE 4	European drivers and road risk
SPACE	Speed Adaption Control by Self-Explaining Roads
2-BE-SAFE	2-Wheeler Behaviour and Safety
DRUID	Driving under the Influence of Drugs, Alcohol and Medicines

At the international level, attention is drawn to transport impacts on inhabitants. Therefore, some European countries (Austria, France, Malta, the Netherlands, Sweden and Switzerland) initiated a joint project in 2003 which included several courses and seminars on the issue of "Transport-related Health Effects with a Particular Focus on Children".

Through this joint initiative and their research the concerned countries want to actively contribute to programmes supported by the EU, mainly by UNECE-WHO - United Nations Economic Commission for Europe - World Health Organization, THE PEP - Transport, Health and Environment - Pan-European Program and CEHAPE - Children's Environment and Health Action Plan for Europe. The goal of all these projects, which focus primarily on road transport, is to make progress towards a unified evaluation of health impacts connected with transport. A range of books were published within the THE PEP project which deals with air quality impacts by transport, traffic noise, transport impact on the population health due to limited physical activity, psychological and social aspects of transport, and economic evaluation. This programme also includes an Internet application for the Clearing House Project (http://www.thepep.org/en/workplan/clearing/ch.htm), whose main objective is the support of price effective instrument for an easy access to information on transport, the environment, and health, including scientific, legislation, and political aspects. The project named HEARTS - Health Effects and Risks of Transport Systems, providing the funds for alternative fuel and environment research, was included in the scheme of UNECE-WHO.

The overview of selected international research projects, with Czech participation in which the issue of transport impact on health and the environment is dealt with, is mentioned in Table 2.

The non-governmental organizations (such as EIROforum and its Members), cooperative associations (such as COST, EUREKA), and other organizations and research associations which conduct and financially support research and development are decisive institutions in European transport research and play an important role in the planning and realization of long-term sustainable transport development (THE PEP, 2004).

3 TRANSPORT RESEARCH IN THE CZECH REPUBLIC

The development of Czech transport research, increase in its competitiveness, and reaching of the level common in developed countries, is based on appropriate human resources and adequate professional workplaces. Regarding the traditional basic transport research in the Czech Republic, organizations are currently dealing with a relatively high average age of researchers, and a high turnover of mainly young researchers. Over the last 10 – 15 years under the influence of external conditions, the transfer of research capacities from organizations typically focused on transport research to private organizations which operate as suppliers in the whole transport chain has occurred. Research istitutes and universities which are not thematically focused on transport are, nowadays, dealing with transport research as well. It is based on the fact that the announced isues of research and development force the applicants to cooperate with several specific research institutes, which rapidly extend the portfolio of cooperating organizations (MD, 2004).

The same process could be found when submitting the applications for European research programmes. The integration of Czech transport research in international research activities, including the use of their results, is one of the priorities of Czech National Policy in the following period. The cooperation will be implemented via the participation of Czech researchers in programmes supported by the EU. It will lead to the integration of a broader spectrum of local research capacities in the European research. The concept of this research space creation puts emphasis and preference on the regionalization of R&D effort. This research regionalization aims to improve research and development at regional universities, and introduce applied research in regional companies, and establish university subsidiaries as they are needed, respectively research institutions in regions with an emphasis

both on cooperation stimulation between the corporate sector and R&D institutions, and the support and development of their own research regional programmes (MD, 2004).

The National Research Programme is particularly represented by projects which were supported by the Ministry of Transport budget and which reflect the national level of transport research up to 2009. Within the programme Safe and Economic Transport (2004 – 2008) possible issues for research projects were announced, which did not omit the field of transport and the environment. These are particularly the issues focused on the support of alternative fuel development in transport, the evaluation of emission impacts on health, traffic noise, fragmentation of landscape caused by the transport infrastructure, etc. Apart from R&D projects, the research programme "Sustainable transport - chance for future" is also in progress, and is divided into several sub-projects covering the majority of problematic issues and some of them are directly linked to projects classified as the 6th Framework Programme of the EU. Regarding the projects announced other resorts, the projects of the Ministry of Environment, the Ministry for Regional Development, the Ministry of Trade and Industry, and Grant agency of the Czech Republic are closest to transport issues. The instruments for the implementation of R&D programmes are calls for proposals, evaluations, and implementation of the selected projects of the appropriate programme. The system of evaluating the research and development in particular resort respects the world trends and uses new knowledge and the best experience from research evaluation in individual member states of the EU, respectively OECD - Organisation for Economic Co-operation and Development. The fundamental evaluation principles are the multi-criteria approach, professional competence, the specific nature, transparency, independence, and objectiveness.

The authority responsible for the development of transport research and development was the Department of Strategy of the Ministry of Transport which was responsible for the preparation, calls for proposals, administration, and evaluation of bids for research projects. The Ministry of Transport is also the founder of the only transport organization, Centrum dopravního výzkumu, v.v.i., which is directly involved in transport research. Besides CDV, the transport research is also conducted at a number of universities, such as the Faculty of Transportation Sciences of CTU in Prague, the Faculty of Mechanical Engineering BUT in Brno, or the Faculty of Civil Engineering VŠB – TU in Ostrava. The environmental issues of transport are dealt with at Jan Perner Transport Faculty, University in Pardubice, at the department of Operational Reliability, Diagnostics, and Mechanics in Transport, including the Section of the Environmental Aspects of Transport and Diagnostics.

The structure of support of the applied research and development in the Czech Republic, where the transport research belong by its nature, was changed in the above-mentioned form in 2009 when the Technological Agency of the Czech Republic was established by Act No. 130/2002, Sb., on research support, experimental development, and innovations, which became effective on 1 July 2009. TA CR assures, on the basis of this Act, programme preparation and realization of its own programmes of applied research, experimental development and innovation; and realization of programmes from governmental departments , research tenders, development and innovations for project support and public procurement, evaluation and selection of the programme project proposals, providing support for work on the programme projects on the basis of treaties, or decisions about providing support and designing the support, as well as the evaluation and control of the research work and meeting the targets of programme projects and control of the achieved results.

Other activities of the newly established agency is the production of the expenditure proposals of the Technology agency of the Czech Republic and its activity reports, provision of consulting services to project partners and users of applied research, development

and innovations mainly in the fields of law, finance and intellectual property protection, communication support between research organizations and the private sector, and the equity financing of programme projects and dealing with the appropriate authorities of the Czech Republic or the European Union in the field of assessing the compatibility of provided support with the common market (TAČR, 2010).

3 FUTURE TRENDS AND VISIONS OF TRANSPORT RESEARCH

The main global objective of transport expressed in transport policy is to satisfy the transport society needs while respecting sustainable development. The role of the public sector is to assure the quality legislation and economic environment for the transport businesses, appropriate infrastructure for mobility, and the provision of services in the public interest also through investments and operational subsidies (Ministry of Transport and Communications Finland, 2005).

The requirement of sustainable transport development is reflected in the economic, environmental, and social field and evokes a need to set the strategic goals for individual transport modes, as well as for cross-sectional fields for the whole sector. Further transport development in the Czech Republic will be implemented within the EU and NATO – North Atlantic Treaty Organization, and therefore the issues of a international nature and regional development will be emphasized. Regarding this situation, it is necessary to follow the system of requirements on the European, national, and regional, respectively local levels, and define the fundamental objectives and attributes which are then becoming the basic research priorities of the programme (MD, 2004).

The "White Paper" of the EU has clearly defined the objectives of European Transport Policy until 2010. The purpose of producing this document was a disproportion of demands of the society for transported needs and the ability of individual countries to assure the implementation of these increasing needs. The fear of the EU bodies comes from the potential lagging behind of Europe in terms of economic growth under the influence of poor quality transport.

Some of the basic goals of the European Transport Policy are as follows:

- keeping the sustainable development level,
- development of a Trans-European transport network TEN for all transport modes,
- interoperability on technical, technological, and information levels,
- inclusion of externalities in the individual transport areas in prices for transport,
- knowledge of all costs in the individual transport fields,
- development of ITS - Intelligent Transport Systems as instruments of repression, control, organization, information, and management in the individual fields of transport,
- development of cycling and recreational water transport,
- transport safety and quality (European Commission, 2001).

The White Paper is not a dogmatic regulation for the EU member states. The responsible institutions, the Ministry of Transport in the Czech Republic, are authorized to transform and adapt the White Paper to conditions of a given country. The paper, adjusted in this way, is then part of transport policies of individual countries.

Various studies show that transport will come to conflict with the sustainable development demands in the future. European road transport networks and urban roads are seriously overloaded, which leads to increased pollution, delays, and other related expenses for users. EEA - European Environment Agency is expecting a certain development in Europe concerning road and air transport, not only because the increase of personal road traffic

at the expense of public traffic is found, but especially due to the growing economics of the EU member states. Moreover, the share of freight transport rises faster than passenger transport in the EU (in the period of 1990 – 2000 the volume of passenger transport increased by 18%, whereas freight transport by 40%). On the other hand, freight transport by rail in Europe decreases annually by 0.6% (ERTRAC, 2006). In all forecasts the EU is expecting this development to continue until 2020 (ERTRAC, 2004). Therefore, the transfer to more sustainable transport modes is necessary, among which are railway, maritime transport for shorter distances, and inland water transport. Therefore, the change in modal split and relieving transport corridors are the main priorities of transport research within the 7th Framework Programme of the European Communities. The EU places particular emphasis on encouraging new investments in Trans-European transport infrastructure, mainly railways, and the development support of an integrated and intelligent European transport system. This partially means achieving a balance between the preferred transport modes via the support of alternative cleaner energy modes, and the development of technologies for inter-modal transport "from house to house". It also means the increase of the existing capacity through research in the field of advanced production processes and traffic regulation systems. The operators and transport infrastructure administrators need to strive to improve the alternative modes and inter-modal transport for end-users (Brůhová – Foltýnová, Máca, 2007).

4 PUBLIC PARTICIPATION IN TRANSPORT RESEARCH

The integration of the public in the decision-making processes, as well as the integration of the public in the transport projects is generally an expression of the democratic decision-making processes. The public involvement is supported by two trends – firstly, from above, through the creation and amendment of corresponding Acts and the continuous reform of the public administration, and secondly, from below, by building a civil society in the form of public initiatives. Both of these trends are intensified, and, up to a certain extent, also determined, by the accession of the Czech Republic into the EU, which supports public involvement. The public integration in transport projects does not have to be only in the decision-making process. The public involvement in the creation of background materials for the decision-making process itself seems to be a more appropriate variation. This concerns various public hearings, round tables, and action weekends, when the political and professional community representatives try to find the priorities of the discussed topics and their possible solutions together with public, through intensive communication with the public. The methods and techniques of such work are well-described in the available literature. Unfortunately, a strong communication culture with the public has not been established in the Czech Republic so far. Comparing to the Western democracies, we have a lot of catching up to do in this respect. Some non-governmental organizations, which put the models of public integration in the decision-making processes into practice, are trying to change the situation.

5 SUMMARY

Transport and transport research are significant bearers of economic activities. They play a crucial role in the assurance of sustainable development, and economic and social growth in Europe. The European transport sector needs to be effective, i.e. creating the appropriate coordination framework, and making the public and private sources equal for the support of the necessary research activities. The use of research project results in practice would be especially important for their realization in the following period. The potential

R&D project application would be beneficial in areas such as the development prediction of individual fields of transport resort, in the regulation and legislation framework design and production, for the development of transport systems, for organizational and other measures in the field of transport safety, for the support of the implementation of new technical and technological solution development leading to a reduction in the economic costs of transport processes, and for the reduction of negative effects of the transport process on the environment (MD, 2004). The new cooperation may also bring positive impacts on human health and the environment after the integration of environmental and health aspects into research activities concerning transport and land use (ERTRAC, 2004).

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Instructions to the authors

1 GENERAL GUIDELINES

Papers based on accepted abstracts and prepared in accordance to these guidelines are to be submitted through the journal's web site www.transportsciences.org. All papers, using Microsoft Word2000 (or newer) are limited to a size of at least 4 and no more than 8 single-spaced pages on A4 paper size (297 mm X 210 mm), including figures, tables, and references and should have an even number of pages. The paper's top, bottom, right and left margins must be 2.5 cm. No headers, footers and page numbers should be inserted.

2 TITLE, AUTHORS, AFFILIATIONS

The title of the paper must be in title letters, Times New Roman, font size 16, and aligned left. Use more than one line if necessary, but always use single-line spacing (without blank lines). Then, after one blank line, aligned left, type the First Author's name (first the initial of the first name, then the last name). If any of the co-authors have the same affiliation as the first author, add his/her name after an & (or a comma if more names follow). In the following line type the institution details (Name of the institution, City, State/Province, Country and e-mail address of a corresponding author). If there are authors linked to other institutions, after a blank line, repeat this procedure. The authors name must be in Times New Roman, regular, and font size 12. The institution details
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The abstract should start after leaving eight blank lines. Type the text of the abstract in one paragraph, after a space behind the word abstract and colon, with a maximum of 250 words in Times New Roman, regular, font size 12, single-spaced, and justified. After leaving one blank line, type KEY WORDS: (capital letters, Times New Roman, font size 12), followed by a maximum of five (5) key words separated by commas. Only the first letter of the first key word should be capitalized.

4 THE TEXT

The main body of the paper follows the key words, after two blank lines (i.e., two blank lines between the first heading and the key words). The body text should be typed in Times New Roman, font size 12 and justified. The first line of the paragraphs should be indented 5 mm except the paragraphs that follow heading or subheading (i.e., the first line of the paragraphs that follow heading or subheading should not be indented). Never use bold and never underline any body text.

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The headings are in capital letters, Times New Roman, font size 12. Subheadings are in title letters Times New Roman, font size 12. The headings and subheadings must be aligned left and should not be indented. Leave two blank lines before and one after the heading. There should be one (1) blank line before and after the subheadings. All headings and subheadings must be numbered. If a heading or subheading falls at the bottom of a page it should be transferred to the top of the next page.

4.2 FIGURES AND TABLES

Figures, line drawings, photographs, tables should be placed in the appropriate location, aligned centre, and positioned close to the citation in the document. They should have a caption, Times New Roman font size 12, with a colon dividing the figure number and the title (Figure 1: Material properties) and should be numbered consecutively, e.g. Figure 1, Figure 2, Table 1, and Table 2.

4.3 REFERENCES

At the end of the paper, list all references with the last name of the first author in alphabetical order, underneath the heading REFERENCES, as in the example. The title of the referred publication should be in italic while the rest of the reference description should be in regular letters. References should be typed in Times New Roman font size 12. citation standard ISO 690.

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