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Managing the Development of the Environmental Protection System in Transport Companies

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Abstract. In the context of economic development, considerable attention is paid to environmental safety. Ensuring environmental safety is one of the most important components of any practical activity, including at transport enterprises. In the Russian Federation, as in most countries with developing economies, environmental protection belongs to the administrative methods of regulation. The main function of the country is environmental supervision. The main task in ensuring environmental safety requirements is the formation and constant development of the environmental protection system at transport enterprises. The article presents the main directions of the impact of transport on the environment and considers the causes of its pollution. The necessity of a systematic approach in solving management tasks for environmental protection and increasing the economic efficiency of transport companies has been substantiated. It is proposed to consider the systemic relationship of production processes, elements, their components, and environmental components in the formation of management decisions at transport enterprises. The authors pay special attention to measures for the legal protection of the environment in the activities of transport companies, the reduction and prevention of negative environmental management.

1. Introduction

Currently, one of the most important problems of mankind is environmental pollution, which affects the development of society, its well-being, the quality of life and human health. Transport companies are also sources of environmental pollution [1].

Transport is an important component of social and economic development, contributes to the growth of economic activity, redistributing labor resources in accordance with the need for the development of productive forces in a particular region [2]. All modes of transport consume a significant amount of resources and have a serious impact on the environment.

1.1. The urgency of this topic

The state of the environment, in which the transport system of Russia is contained and operated, is one of the most important and urgent problems of our time, which is growing every year. And to solve it, it is necessary to develop measures aimed at eliminating negative consequences. Environmental protection should be a system of measures, on the one hand, aimed at ensuring favorable and safe conditions for the environment and human life, and, on the other hand, thought out and implemented



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at every enterprise, including transport [3]. Environmental safety provided by each mode of transport in the modern world is one of its main competitive advantages.

1.2. Literature review

The issues of environmental protection in transport companies were considered in the works of scientists: Galaburda V.G., Tereshina N.P., Besspalov V.I., Kuzina E.L., Vladimirova S.N., Marchuk K.A., Akhmetova L.A., Korneva E. V., Sitshaeva T. Z., Bobrovnikova N. A., Golubeva I.R., Novikova Yu.V., Evgenieva I.E. , Savina V.V., Enenkova V.G.

1.3. Problem statement

According to the Decree of the President of the Russian Federation of 19.04.2017 N 176 "On the Strategy of the Environmental Safety of the Russian Federation for the Period up to 2025", it is necessary to deepen and expand the boundaries of scientific research in the field of environmental protection in transport [4]. The existing environmental legislation in Russia is not only an effective mechanism for the implementation of existing and accumulated environmental problems, but also an attempt to environmental protection [5].

Structural transformations in the economy lead to an increase in demand for all types of transport services, to the need to improve transport infrastructure [6]. The main goal of every transport company in the field of ecology is to take care of environmental safety and human health. The strong impact of transport on the environment is due to the high popularity and quantity of transport.

1.4. Theoretical basement

Environmental safety is defined as a set of states, processes and actions that ensure an ecological balance in the environment and do not lead to vital damage to the natural environment and humans. It is also the process of ensuring the protection of the vital interests of the individual, society, nature, the state and all mankind from real or potential threats created by anthropogenic or natural impact on the environment [7].

A unified transport system ensures the coordinated development and functioning of all modes of transport in order to maximize transport needs at minimum costs [8]. The transport complex includes vehicles and transport mechanisms that move by land, water and air. The transport system includes road, water, rail, aviation and pipeline transport, each of which contributes to environmental pollution.

2. Practical significance

The transport system is the main cause of the environmental problem - the depletion of natural resources (hydrocarbons, metals and metal ores):

1. Washing of all types of transport pollutes water bodies.
2. The required regular disposal of used consumables of vehicles: tires, batteries, scrap metal, plastic, household waste, causes great harm to the environment and human health.
3. Pollution of the environment by transport occurs due to noise, vibration, thermal and electromagnetic radiation, the ingress of fuel combustion products into the atmosphere, evaporation and leakage of oil products onto the soil and water, which, being included in the circulation of substances and energy, pollute the environment, harm the existence of all living organisms.
4. During the operation of transport, harmful substances enter the atmosphere, smog is formed, the ozone layer is destroyed.
5. The most dangerous substances emitted by modern modes of transport are carbon monoxide, dioxins, carbon monoxide, benzopyrene, nitrogen oxides, lead compounds, therefore an unfavorable situation develops in the atmospheric air [9].

Air pollution by all modes of transport is shown in Figure 1.

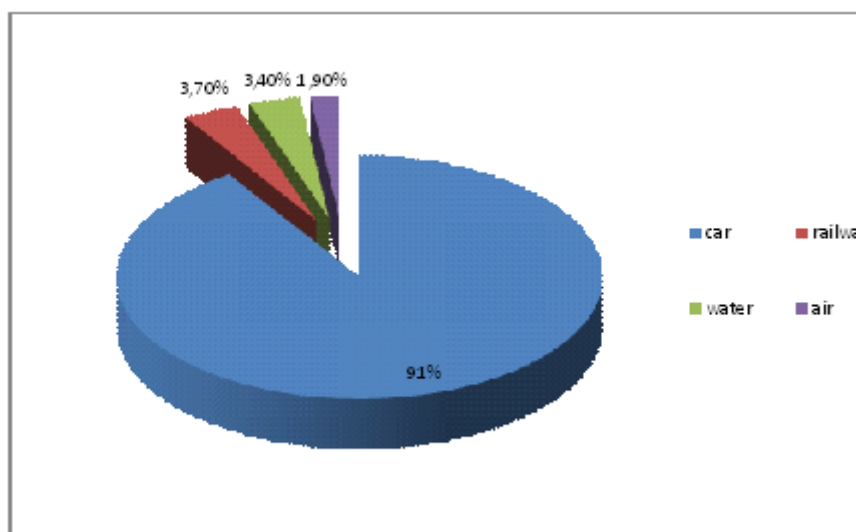


Figure 1. Air pollution by all types of transport.

As can be seen from Figure 1, the main threat to atmospheric air comes from road transport. However, rail, water and air transport is also harmful, but in smaller volumes.

The annual environmental damage associated with the operation of the transport complex in Russia is estimated at \$ 3.7 billion. Almost 80% of this damage is caused by atmospheric pollution with harmful emissions of fuel combustion products [10]. The negative impact on the environment of all modes of transport in Russia is shown in Figure 2.

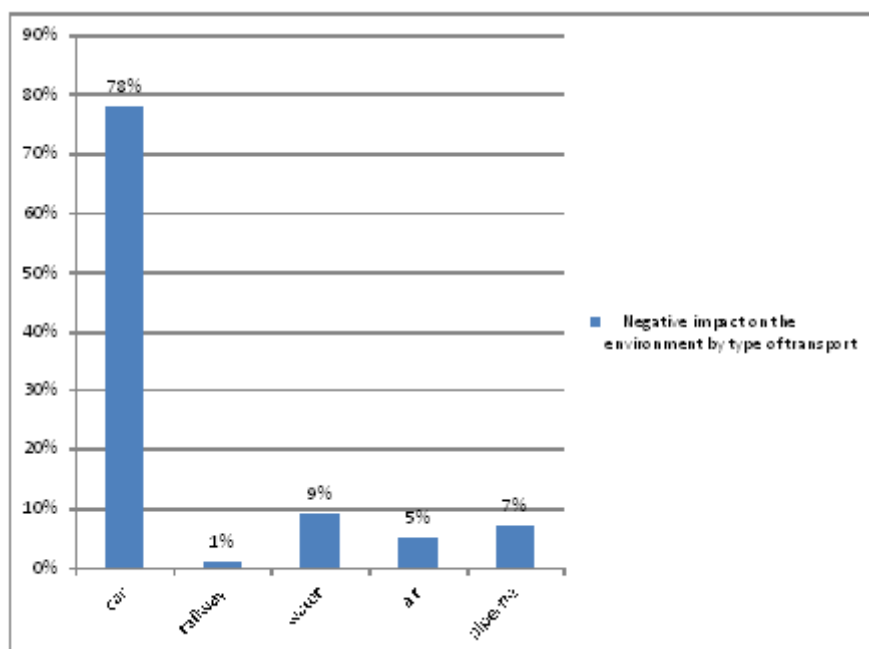


Figure 2. The negative impact on the environment of all types of transport in Russia.

As can be seen from Figure 2, railway transport is one of the most environmentally friendly, while emissions of pollutants into the atmosphere are 1%, despite the fact that railway transport forms the

basis of the state transport system, ensures the functioning and development of the country's economy and plays a key role in ensuring needs of the population in transportation.

With the help of railway transport, 80% of cargo transportation is carried out, and passenger turnover is 40%. The consumption of natural resources increases in accordance with the amount of work, while the amount of emissions is minimal compared to other modes of transport.

Water transport pollutes the environment by 5%: deterioration of the biosphere due to waste emissions into the air during the operation of water transport; environmental disasters that occur during various accidents on ships associated with toxic products; harmful substances, penetrating into the atmosphere, return to the water along with precipitation; on tankers, the containers are periodically washed to wash off the remains of the transported cargo. This contributes to the pollution of water bodies. The impact of water transport on the environment is to reduce the level of existence of aquatic flora and fauna [11].

The most popular form of transport in terms of pollution is road transport. Recently, there has been a steady increase in the number of cars, a constant increase in the length of roads [12]. Emissions from road transport in Russia amount to about 23 million tons per year. Oil products, wear products of tires and brake pads, loose and dusty products, chlorides used to solve the problem of icing of road surfaces, clog the road lanes and water. Once in the atmosphere, these chemical compounds mix with pollutants present in the air and undergo many complex transformations, leading to the formation of new compounds that are even more harmful to the environment and public health.

Automobile transport uses gasoline fuel (gasoline) as fuel, one ton of which emits up to 800 kg of harmful substances during combustion. But if the engine runs on leaded gasoline, then a pollutant such as lead gets into the air, which easily settles down and pollutes the soil. When car tires rub against the asphalt, rubber dust gets into the air. It penetrates into the respiratory organs of a person and worsens health. Road transport emits harmful substances into the atmosphere and absorbs oxygen. One car in a year of regular operation destroys over four tons of oxygen. Roadside dust formation resulting from the operation of vehicles contains more than 200 units of chemical substances, many of which may be radioactive [13].

Trains and other components of the industry annually consume about 7% of all produced fuel in Russia, about 6% of electricity, as well as up to 4.5% of forest resources [14]. The impact of railway transport on the environment is reflected in a large amount of mechanical solid waste, heat radiation and vibrations that negatively affect living beings. The railway sector is a source of danger to soil and water resources. As a result of the activity of each locomotive depot, industrial wastewater remains. They contain petroleum products, bacterial dirt, suspended particles, acids, alkalis, surfactants. All this easily gets into the ground and water, poisoning them.

At the present time, an unfavorable environmental situation can be traced in absolutely all domestic cities with a population of more than 1 million people, in 60% of cities with a population of 500 thousand to 1 million and in 25% of cities with a population of 250 to 500 thousand people [15]. Approximately 1.2 million people in the Russian Federation (hereinafter referred to as the RF) are strongly affected by an acute environmental load, and more than 50% of the inhabitants of Russian cities feel a high noise impact [16].

There is an opinion that water transport is considered environmentally friendly, but, unfortunately, this is not the case. Sea and river vessels worsen the state of the biosphere due to operational waste, as well as occasional accidents on ships with toxic cargo (oil and oil products) are the causes of real environmental disasters. On the other hand, tankers engaged in oil transportation regularly wash their tanks to remove previously transported products. The result of this removal is water saturated with oil residues. Usually it, without thinking about the damage, is simply poured overboard, thereby harming the aquatic flora and fauna [17].

The main factors of the negative impact of air transport on the environment are engine emissions, high noise injection and sonic booms typical for flights at supersonic speeds [18]. Harmful emissions, which comprise about 65% of carbon dioxide, about 30% of water vapor and 2-5% of pollutants such as oxides of sulfur, nitrogen, hydrocarbons and carbon monoxide, are in close proximity to the ozone

layer, destroying it. Thus, airplanes make a fairly significant contribution to the formation of the greenhouse effect on the planet. And he is the primary cause of global warming, which leads to very serious consequences. [19].

The operation of any type of transport consists in the use of operating materials, oil products, natural gas, atmospheric air, and all this is accompanied by negative processes [20].

The main types of transport impact on the environment are shown in Figure 3.

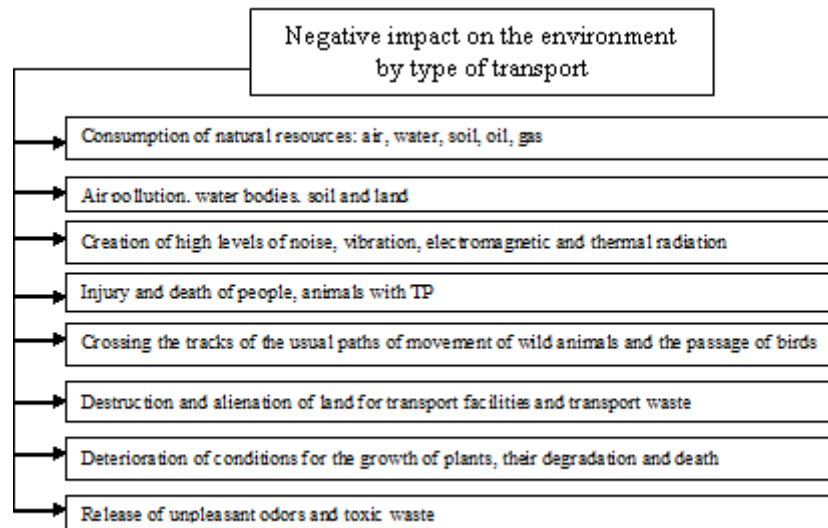


Figure 3. Types of transport impact on the environment.

The main reasons for the negative impact of the transport industry on the environment are shown in Figure 4.

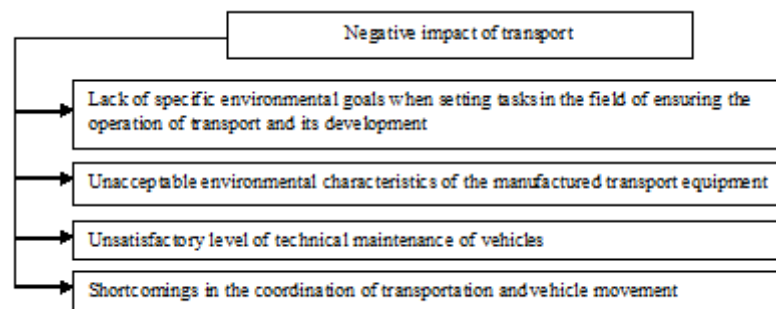


Figure 4. Reasons for the negative impact of the transport industry on the environment.

The causes of environmental pollution by various modes of transport are presented in Table 1.

Table 1. Causes of environmental pollution by various modes of transport.

Kind of transport	Causes of environmental pollution
car	- the flow and combustion of petroleum products; - clogging of water resources; - soil contamination with residues from worn out tires; - losses during transportation of bulk, liquid and dust cargo; - pollution of land plots with gasoline, oils, exhaust of solid and liquid components, salts, pollution with chlorides used for sprinkling roads in winter; - harmful dust emitted by poor quality asphalt; - noise (from the operation of motors, wheel movement, braking and aerodynamic features of vehicles).
railway	- waste, heat radiation, vibration, noise; - concentration of excessive noise, vibration, thermal and electromagnetic radiation along railway tracks and stations; - contamination of territories with waste gases, fuels and lubricants, metal shavings, drainage dirty water, sewage, and the multiplication of microorganisms in them; - the territories adjacent to the railway, soil and water resources are littered, soil fertility decreases, preconditions for erosion are created, harmful substances accumulate in the adjacent agricultural areas; - damages the flora and fauna; - water pollution from vapors of crude oil, gasoline, during their transportation and intermediate storage; - accidents on the railways cause significant widespread pollution of all components of the environment.
air	- noises generated by aircraft and helicopter engines, airport equipment, aircraft repair and maintenance facilities; - electromagnetic radiation from radar and radio navigation equipment, vibration, fuel combustion products, thermal radiation; - industrial waste water containing oil products, bacterial dirt, acids, alkalis and other harmful substances that get on land and water bodies.
water	- food waste, garbage, fuels and lubricants, lost cargo, ballast water, and water used for cooking and hygiene purposes get into the water; - exhaust gases from engines get into the air; noises, vibration are created.
pipeline	- at the stage of pipeline construction, natural landscapes are disturbed, significant areas of land are withdrawn from agricultural use, adjacent territories are littered; - pipelines corrode over time, sag and crack at the joints, and as a result, a significant amount of pollutants gets into the adjacent territories, which are accompanied by explosions and fires.

In order to prevent or reduce environmental pollution by various modes of transport, it is necessary to use the methods of system analysis when solving issues of management of such a complex developing object as the transport system in general and each transport company in particular.

Based on the fact that the methods of system analysis are identical to the methods for solving the problems that have arisen, then they can be classified in accordance with the individual stages of the decision-making process and used to solve complex semi-structured problems.

Consider the stage of analytical modeling of management, taking into account the requirements of environmental protection in the production and technological management system of a transport company. Let Z be the set of state variables, Ξ be the set of parameters of the system S , and X be the set of inputs to the system. System function F describes the behavior of the system and generates a set of outputs Y , i.e.

$$F(Z, X, Y, \Xi) = Y \quad (1)$$

Let us select from the set of states Z a subset of controlled states U taking into account environmental requirements, from the set Ξ – a set of controlled parameters θ taking into account environmental requirements. Now the function for some values from the sets Z , U , X , Ξ , θ has the following value:

$$F(Z, U, X, \Xi, \theta) = Y^* \quad (2)$$

Let us assume that Y^* is the result of admissible management while ensuring environmental protection. Now the target control function can be represented as:

$$F^* = F(Z, U, X, \Xi, \theta) - Y^* \quad (3)$$

Let us consider the application of the goal function F^* , taking into account environmental protection measures in systemic management tasks.

Let the function F reflect some efficiency of the transport process, taking into account environmental safety and social orientation, the function g sets the technological constraints, and the function f models the transport technological process. It is necessary to find such a control of the states of the system so that the value of the objective function F^* is the smallest, but positive.

Suppose that to study the transportation system we have:

$U = \{U_i, i = 1, N\}$ – a set of methods for solving problems of the development of the transportation system;

$S = \{i = 1, N\}$ – set of costs corresponding to set U ;

$5 = \{5_i, i = 1, n\}$ – set of objectivity indicators using U set methods for research and development of the transportation system;

$R = \{R_j, j = 1, m\}$ – the maximum number of sources that can influence the development of the transportation system.

The purpose of managing the transportation system in an environmentally friendly manner should be formulated as follows:

from the set $U = \{U_i, i = 1, N\}$ find a subset of U , characterized by subsets A and S and how e , minimizing the functionality: $C = f_1(AU, AS)$, regarding the limitation: $R > f_2(AU, AS)$.

To select the goals for the development of the national system of freight transportation, taking into account environmental protection and methods for solving these problems, it is necessary to make a target function, define a set of development management goals and a set of methods for their solution by the MA, constantly analyzing the functioning of the transportation system and freight flows.

The search for a numerical solution to the optimal control problem taking into account environmental protection requires the development of an algorithm different from the standard one, or

the transformation of a typical problem with standard computation procedures. Therefore, intelligent transport systems should include algorithms for solving optimal control problems, taking into account the fulfillment of environmental protection requirements [21]. The application of the system analysis methodology, namely the development of a management and decision-making system taking into account environmental requirements in conditions of uncertainty, allows creating new subsystems, and thereby improving the operational capabilities of intelligent systems of all types of transport.

The main directions of effective environmental protection activities of transport companies and their expected results are presented in Table 2.

Table 2. Directions and results of environmental protection activities in transport.

Directions	Result
Strict adherence to the rules for transporting people and goods	The work of transport is more optimal, economically profitable, reducing the consumption of energy, fuel and other resources.
Reconstruction of engines	Reducing fuel consumption per unit of mileage, reducing noise and vibration (due to fundamentally new technological solutions), reducing the content of harmful impurities in exhaust or waste gases.
Development of new types of engines	The minimum degree of environmental pollution.
Development of new fuels (more environmentally friendly)	When they are burned, a small amount of substances is formed that have a negative impact on human health and natural environmental processes.
Optimization of the driving mode, excluding the occurrence of "traffic jams" and other difficulties when moving vehicles.	Reducing engine speed will reduce harmful pollutants.

Legal protection of the environment, which is as important as economic measures, in transport includes the implementation of the measures presented in Figure 5.

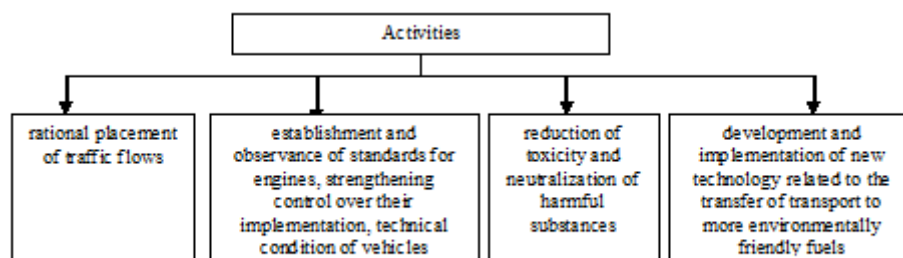


Figure 5. Measures for the legal protection of the environment in transport.

Reducing the harmful effects of all types of transport on the state and health of the country's inhabitants and the environment can be achieved if there is a massive transition to the operation of vehicles operating on environmentally friendly fuels [22]. To reduce and prevent the negative impact

of all types of transport on the environment, it is necessary to adhere to the restrictions presented in Table 3.

Table 3. Restrictions in making management decisions to reduce and prevent the negative impact of all types of transport on the environment.

Kind of transport	Limitations in making management decisions
Car	1.To use environmentally friendly fuels, internal combustion engines with increased efficiency, emission reduction devices. 2. The use of recycled water supply in the processes of car washing. 3.Improving the general technical condition of cars and strengthening control over it, restricting the import of old cars with low performance into the country, redevelopment using multi-level transport interchanges, ring roads, landscaping the motorway, moving residential areas at a safe distance from them, creating sanitary protection zones. 4. Application of various methods of tire recycling, widespread use of underground car parks, control of noise levels on the roads, installation of transparent protective noise barriers.
Railway	1. Reducing the content of harmful substances in the exhaust gases of diesel locomotives; 2. Taking measures to prevent accidents on railway tracks; 3. Application of water purification technology; 4. Establishment of tanks for collecting sewage and their processing.
Air	1. Reducing the amount of waste gases; 2. Reducing noise by increasing flight altitude and reducing landing time; 2. Reducing the mileage of aircraft at airfields due to their towing by tractors to the runway.
Water	1. Reducing the accident rate of ships and preventing the loss of oil and oil products. 2. Prohibition of discharges of polluting waste in internal waters. 3. Installation on ships of additional means and containers for the disposal and disposal of part of the waste.
Pipeline	1. Application of advanced technologies for construction and operation of pipelines. 2. Timely pipeline diagnostics.

3. Conclusion

Thus, the tightening of the country's legal framework in the field of ecology can significantly reduce the harm caused to the environment during the operation of vehicles. The adverse impact of vehicles corresponds to the amount of damage, which is the diversification of the usefulness of the environment due to the influence of unfavorable conditions on it [23]. Environmental pollution due to the operation of vehicles, railways, water and air transport damages the quality of ecological systems, the health of residents and economic activities [24].

Consequently, the formation of an environmental protection system in each transport company, which will force them to comply with the basic rules related to toxic waste, make cost-effective, environmentally friendly, socially oriented management decisions and will guarantee the creation of a

healthy environment, increase the level and life expectancy of the population, which will lead to the subsequent social and economic development of the state.

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