Some aspects of modern automobile transport development

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Abstract. The paper treats modern automobile transport development tendencies. In this regard, the main focus is on safety and ecology. Road accidents (hereinafter referred to as RA) are one of the main causes of death in the world, and every year they claim over 1.35 million lives, lead to injuries of up to 50 million people, and are ranked eighth among the main causes of death for all age groups. The economic losses caused by RAs in some countries reach 5% of the gross domestic product, in the Russian Federation this share is around 2%. The transport sector produces 18% of all global anthropogenic emissions and 23% of greenhouse gas emissions related to the energy industry. 3 million people die annually due to air pollution. A part of the listed problems can be solved by means of increasing vehicles' autonomy and by creating driverless vehicles, the advantages of which are evident: safety - minimization of RAs which mostly occur due to human error; environmental friendliness - quantity optimization of the vehicle fleet, road traffic organization (optimal selecting route and driving modes) and decrease of fuel consumption (selecting driving modes); economic efficiency - decrease of costs for insurance and rapid-response (emergency) medicine in case of RA, decrease of cargo and people transportation costs by means of economizing driver's salary and economizing fuel.

1. Introduction
The strategic goal of the development of the transport system of any state is to satisfy the needs of the economy and society in quality transport services. In the Russian Federation, due to its geographical features and the specifics of the territorial distribution of productive forces, transport plays a key role in the economy. Therefore, the government has always paid and pays much attention to the effective, safe and high-quality development of the transport system. In this case, special attention is paid to road transport.

2. Freight and passenger transportation
In the Russian Federation, more than two thirds of cargo is transported by road (Figure 1 [1, 2]).

![Figure 1. The structure of cargo transportation in the Russian Federation.](image-url)
The share of passenger transportation by road is 66%, and with urban electric transport – 89% (Figure 2 [1, 2]).

![Passenger transportation (million passengers)](image)

**Figure 2.** The structure of passenger transportation in the Russian Federation.

At the same time, transportation carried out on personal vehicles, which dominates the general fleet of motor vehicles of the country, is not taken into account.

**Fleet of vehicles**

At present, the domestic fleet of motor vehicles, registered with the State traffic inspectorate, reached more than 57.1 million units excluding trailers and semi-trailers (Figure 3).

![The dynamics of the growth of the fleet of vehicles in the Russian Federation (million units)](image)

**Figure 3.** The dynamics of the growth of the fleet of vehicles in the Russian Federation (million units).

The number of cars reached 47.4 million units or 78.3% of the total number of vehicles, buses – 0.86 million (1.5%), trucks - 6.48 million (10.7%), motorcycles – 2.32 million (3.8%), trailers and semi-trailers – 3.4 million (5.7%). At the same time, 54.6 million units or 90% of the country's total vehicle fleet are owned by individuals [1, 7].

**3. Fleet Age**

A characteristic feature of the fleet is a significant proportion of outdated vehicle models with long service life. About 47.5% of cars, 61.7% of trucks, 50.6% of buses and 89.5% of motorcycles have been in operation for over 10 years. Over 35% of the fleet has been in operation for more than 15 years (Figure 4 [1]).

The consequence of the presented statistics is a decrease in the technical reliability of vehicles (as mileage increases, fatigue stresses in the structure increase by 1.4 - 2.5 times), lag behind modern requirements for passive, active and environmental safety, increasing the likelihood of sudden failure of components and assemblies in the process of traffic and, as a result, an increase in the probability of an accident due to a technical malfunction.
Figure 4. Distribution of the fleet of vehicles by types and times of operation.

The other side of these statistics is the low environmental friendliness of the domestic automobile fleet (Table 1 [7]).

| Ecological class | Vehicles registered in the Russian Federation | Number of vehicles |
|------------------|---------------------------------------------|--------------------|
| 0                | 2577456                                     |                    |
| 1                | 753498                                      |                    |
| 2                | 3231777                                     |                    |
| 3                | 5932642                                     |                    |
| 4                | 14885092                                    |                    |
| 5                | 10195149                                    |                    |
| 6                | 35637                                       |                    |
| not established  | 17168375                                    |                    |

4. Traffic accidents
Worldwide, among all modes of transport, road transport is the most dangerous. It accounts for 97% of all deaths in transport [8] or 1.35 million deaths a year. Traffic accidents cause injuries to 50 million people and take eighth place among the leading causes of death for all age groups at the world level [10].

According to the United Nations Economic Commission for Europe (hereinafter - UNECE), road traffic crashes cause significant economic damage, which in some countries reaches 5% of the gross domestic product. The annual economic losses of the Russian Federation from accidents amount to about 2% of the gross domestic product [6].

These losses are directly related to material costs in case of mechanical damage to vehicles and road infrastructure, as well as to lost income from death and disability of the able-bodied population, expenses for treating victims, and social support for people with disabilities, as a result of which road safety issues remain the most relevant in the modern world, including Russia.

Over the past several years, measures have been taken in the Russian Federation to increase the protection of road users. Due to this, the trend of decreasing the main accident indicators [1], which has been existing since 2012, continues (Figure 5).
However, despite some positive changes, the level of road traffic accidents in the country remains high. At the end of 2018, 168.1 thousand incidents were registered, in which 18.2 thousand were killed and 214.9 thousand people were injured.

The reasons for 88.1% of incidents were violations of the Traffic Laws of the Russian Federation committed by drivers of vehicles. Moreover, almost every tenth accident occurred with the participation of drivers in a state of intoxication.

The most common types of accidents are vehicle collisions (42.3%) and pedestrian collisions (29.1%). Most pedestrian accidents (67.5%) are due to violations by drivers. Almost three quarters of these incidents occurred in the dark, in which 84.6% of pedestrians died. These incidents are characterized by the most serious consequences - fatal injuries sustained by pedestrians in almost every second case [1].

International priorities in the field of road safety in developed countries are defined by the slogan “above zero”, that is, targeting zero mortality on the roads. In accordance with the tasks set by the Transport Strategy until 2030, one of the most important tasks is to reduce the number of deaths in a traffic accident per year per 10 thousand cars by more than 60% [4].

This problem is planned to be solved not only through the formation of a regulatory framework, improved traffic management and control activities, but also through the use of intelligent transport systems in road transport and road infrastructure, as well as improving the design of vehicles, including the development of unmanned vehicles.

5. Ecology

According to UNECE, 3 million people die every year from environmental pollution. In one projection, energy-related CO2 emissions are expected to grow by 40% between 2013 and 2040. The transport sector accounts for 23% of global energy-related greenhouse gas emissions and 18% of all anthropogenic emissions in the global economy. Moreover, from 70% to 84% of fuel energy is lost in engines and inefficient drives [8].

The 2010 report, Energy for a Sustainable Future, set out recommendations that laid the foundation for the three goals of the Sustainable Energy for All (SE4ALL) initiative: affordability, efficiency and renewable energy.

In order to implement the Climate Doctrine of the Russian Federation, approved by Decree of the President of the Russian Federation dated December 17, 2009 No. 861-rp, the Government of the Russian Federation must ensure by 2020 the reduction of greenhouse gas emissions to no more than 75 percent of the volume of these emissions in 1990 [5].

Reducing the negative impact of the transport system on the environment is also one of the important goals of the transport strategy. It is planned that resource-saving, energy-efficient and environmentally
friendly materials and technologies, alternative fuels, and environmental safety systems will be introduced in the transport complex.

Compared with 2007, carbon dioxide emissions from the transport complex should decrease by 15% by 2030 (Figure 6), the share of alternative fuels in the total fuel consumption of vehicles will increase to 30%, the share of vehicles using alternative fuels (hybrid and electric vehicles, vehicles with gas and hydrogen engines) can reach half the fleet [4].

![Figure 6. Forecast of carbon dioxide emissions by automobile transport until 2030.](image)

Measures to reduce the negative impact of road transport on the environment and public health can be divided into the following areas:

- improving environmental safety and energy efficiency of operating vehicles;
- improving the quality of traditional motor fuels and expand the use of alternative energy sources;
- improving transport infrastructure, transport planning, traffic management, development of public modes of transport;
- measures in the field of managing transport behavior (mobility) of the population (switching to public transport, taxi and car sharing, including unmanned cars).

6. Trends

In accordance with the goals set by the Transport Strategy until 2030, one of the most important tasks in the field of automobile transport is to increase road safety and reduce harmful emissions into the atmosphere. These tasks should be largely solved by improving the design of vehicles.

According to the Strategy for the Development of the Automotive Industry until 2025, approved by Decree of the Government of the Russian Federation dated April 28, 2018 No. 831-r (hereinafter referred to as the Strategy), the global automotive industry is currently characterized by a set of global trends that also affect the development of the Russian automobile market and the automotive industry generally. The main ones are as follows [3].

- Electrification of vehicles. According to experts, in 2020, the share of electric vehicles in the total world output will be at least 17%, of which 75% will be in hybrid cars, and the total number in the global fleet will reach 20 million or 1.7%.
- Improving the autonomy of vehicles. Increasing the autonomy of vehicles will require addressing issues, including cybersecurity, regulation of property rights and data management, the distribution of responsibilities in road accidents, and the development of a new regulatory environment.
- Implementation of network (telecommunication) technologies in transport systems. The introduction of telematics systems can increase transport capacity by 25%, passenger turnover by 20%, cargo turnover by 5-10% while reducing the number of accidents to 60%.
- For the Russian Federation, the priority areas for the development of the automotive industry are improving the environmental performance of vehicles, passive and active safety, autonomy and robotization of vehicles, the use of intelligent security and control systems, informatization and computerization.
It is assumed that the implementation of the measures provided by the Strategy will ensure the renewal of the fleet of vehicles of all types and the emergence of a new line of products (electric vehicles and unmanned vehicles) with sales growth rates of about 40-50 percent per year [3].

7. Findings
By 2030, annual passenger traffic will increase by 50 percent, and global freight traffic by 70 percent. By 2050, approximately 1.2 billion more cars will enter the road [9]. All this leads to unsustainable mobility - deaths in transport, the intensive use of fossil fuels, large greenhouse gas emissions and increased environmental pollution by harmful emissions and noise.

Some of these problems can be solved by increasing the autonomy of vehicles and creating unmanned vehicles, the advantages of which are obvious:

- safety - minimization of accidents that occur mainly due to the human factor, transportation of goods in hazardous areas, during natural and man-made disasters or military operations;
- environmental friendliness - reducing the global environmental load both due to quantitative optimization of the car fleet, and due to the organization of road traffic (optimal choice of route and driving modes) and reduction of fuel consumption;
- cost-effectiveness - reducing the cost of insurance and quick-response medicine in case of an accident, reducing the cost of transporting goods and people by saving on wages, driver rest time and fuel economy, increasing the efficiency of road use by centralizing traffic flow and increasing their capacity;
- social orientation - the ability to independently travel in a robotic car for people without a driver’s license, including minors, and people with visual impairments.

At the same time, it seems expedient, first of all, to automate urban passenger (buses, trolleybuses and taxis / car sharing) and freight (mail, school meals, etc.) transportations carried out on established routes. For these transportations, it is not necessary to have constant communication with satellite systems of global positioning and Internet connection, it is only necessary to have an appropriate processor with an operating algorithm and memory with a detailed high-resolution terrain map (HD-map).

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