

Motorization in Russia: challenges and solutions

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Abstract- Present paper reports about the results of research on motorization level in the regions of the Russian Federation. The most car-dependent city and region were identified. We have made a review of such negative consequences of motorization as traffic accidents, road congestion, environmental degradation, noise and vibration. A quantitative evaluation of these hostilities in the Russian cities was made. We also proposed the solutions of the traffic problems, caused by the growth of the automobile fleet.

Keywords- Motorization, negative consequences of motorization, traffic safety, road congestion, environment, noise, public transport.

1. Introduction

Transport is a necessary condition for the functioning of modern society. It is impossible to imagine life without it. Transport is one of the largest basic industries and the most important element of the industrial and social infrastructure in the Russian Federation, as well as in the other developed countries. It exerts a significant impact on the agility and efficiency of social and economic development both of the regions and the state as a whole.

Cars are the most massive integral part of the transport infrastructure. They are characterized by the maneuvering ability, high speed of goods delivery, while providing transportation directly from sender to recipient, and mobility which makes it possible to give quick feedback on changes in passenger and freight traffic (Ugay et al., 2013).

Currently, one of the main problems of the transport sector in Russian cities is the spontaneous growth of vehicle-to-population ratio.

An intense increment of vehicles under the acute shortage of the road network capability and unsatisfactory road surface condition results in traffic congestions, traffic accidents increase, environmental degradation, obstruction of the passenger traffic objects availability, and lack of vehicles storage space (Bats, 2014).

Thus, along with a positive effect on the economy and social development of countries motorization also bears some negative consequences associated with a large number of traffic accidents with fatal and injured victims, vast

financial damage, negative impact on the ecological state of the urban environment, and cluttering of streets by parked cars (Gorev & Oleshchenko, 2006; Kasatkin et al., 2004).

Under the modern conditions the problem of mass motorization is not only one of the key problems of urban development, but also becomes increasingly important in terms of the national economic significance, as well as social and even public policy performances.

Increased motorization of the country requires systemic measures aimed at limiting its negative consequences for society, along with the largest possible realization of its advantages and benefits.

1 Methods

Each study should usually consist of four main stages as follows:

1. The development of program project and research methodology.
2. Incubation of research.
3. The research process itself.
4. Data processing and reporting.

The goals and objectives of the study, as well as the place, time and survey scope, necessary equipment and machinery, number of performers of the work, are determined at the first stage. During the second stage it is usual to tool up the equipment and prepare the performers, conduct a preliminary research the results of which specify the program and methodology of the study. The overall success depends largely on the performance of the first and second stages (Klinkovshtein & Afanas'ev, 2001).

Correctly chosen method of investigation determines the obtaining of reliable results.

To carry out this study the following research methods were used:

- Investigation.
- Measurements.
- Observation.
- Statistical studies, based on collecting and processing of the State Statistical Report data.

For the purpose of statistical studies both absolute and relative measures are used. For instance, it is not correct to compare the levels of noise, accidents or emissions in different cities and regions. It is more accurate to adduce the

levels of these indicators in comparison with the level of motorization.

2 Results

2.1 Motorization in Russia

In 2010, the number of cars all over the world has risen beyond one billion. This became known due to the research conducted by "Wards Auto" Company. The total number of vehicles including cars, trucks of different types, excluding heavy off-road vehicles, and buses totaled 1.015 billion.

It is notable that in 2009 there were 980 million registered vehicles in the world. And just three decades ago, in 1986, there were 500 million. The number of cars continues to grow inexorably. Currently, world vehicle-to-population ratio is almost 1 to 7 (The number of cars or statistical reasoning in traffic, 2015).

Motorization rate is a value of the population having cars, which is calculated as the number of individual passenger cars per 1,000 inhabitants. Motorization rate is calculated according the method of the International Road Federation, based on the data of national statistics and international organizations. The source of information is a database "World Road Statistics", which is updated annually.

The quantity of cars is growing more and more every year. Up to date, the highest ratio of motorization is registered in USA, Canada, Australia and some countries in Western Europe. Russia ranks 52 by the number of cars in the world (Motorization of Russia: to catch up and overtake Libya, 2015).

According to the data of analytical agency "AUTOSTAT", at the beginning of 2015 year 284 passenger vehicles accounted for thousand people in Russia. A year earlier this rate was 10 cars less, only 274 vehicles per 1,000 inhabitants.

At the same time this figure exceeds 300 vehicles in Moscow, St. Petersburg and many other major cities in Russia. In addition, the extremely high number of cars per population is registered in Primorsk and Kamchatka krais, as well as in the Kaliningrad oblast.

Over the past 13 years since "AUTOSTAT" agency has been keeping the automobile statistics, the number of cars per population in Russia has increased twice. At the beginning of 2002 year this rate was 144 cars per thousand inhabitants. And the greatest increase was recorded in 2007, 2008 and 2012 (18, 19, 16 units, respectively).

It should be noted that on January 1, 2015 the car fleet in the Russian Federation was 40,850,000 units that is 3.9% higher than a year earlier (For every 1,000 Russians - 284 passenger cars, 2015).

Talking about the federal districts of the Russian Federation, we shall mention that according to the data of "ALFASTRAKHOVANIE" (ALFA INSURANCE) research center the highest percentage of car ownership is observed in the Far East district, where 326 vehicles accounted for every thousand inhabitants in 2013 year (Alfa Strakhovanie: Security Russians cars for the year increased by 3.2%, 2015). Northwestern Federal District ranks 2 in the number of car ownership with the ratio totals 280 cars per thousand inhabitants. Central Federal District ranks 3, having the ratio of 278 cars per thousand inhabitants.

The highest percentage of car ownership throughout the Far East region was recorded in Primorsk krai. There are 572 cars per thousand people here (Table 1) (Motorization of Russia: to catch up and overtake Libya, 2015).

Table 1. Russian Federal district with the highest vehicle-to-population ratio

RF District	Amount of cars per 1,000 people
Primorsk krai	572
Kamchatka krai	458
Kaluga oblast	344
Moscow oblast	340
Kaliningrad oblast	336
Pskov oblast	334
Republic of Karelia	329
Ryazan oblast	312
Tomsk oblast	312

However, the experts note that one of the reasons for such a high rate of motorization in the Far East is the fact that a large number of cars are recorded in the Primorsk and Kamchatka krais only formally, while actually the foreign cars, imported through the Far East, are driven in other areas of Russia.

In 2013, the highest vehicle-to-population ratio among the cities in Russia was registered in Vladivostok. It makes up 566 vehicles per thousand inhabitants. As a comparison, the Krasnoyarsk city, ranking 2 in the number of car ownership, has 384 cars per thousand inhabitants. And this ratio amounts to 338 cars per thousand people in the capital of Russia, which ranks 7th (Table 2) (The concentrations of cars in Russian cities, 2015).

Table 2. Car ownership rate in the Russian cities

The city	Amount of cars per 1,000 people
Vladivostok	566
Krasnoyarsk	384
Surgut	377
Tyumen	374
Krasnodar	350
Kaliningrad	338
Moscow	338
Nizhnevartovsk	334
Penza	297
Kaluga	293

It should be noticed that Vladivostok has been constantly keeping the highest rate for several years.

2.2 Negative consequences of motorization

Due to such advantages of the automobile transport over the other modes of transportation, as high speed delivery of goods and passengers, mobility, ability to provide "door to door" delivery of cargo and passengers, and relative simplicity of operation, its role in the world transport system is steadily increasing.

On the one hand, the technical and social progress of society is impossible without road transport. On the other

hand, the development of motorization, steady growth of the operating vehicles fleet, increasing traffic causes so-called negative effects of motorization; the main ones are as follows:

- Traffic accidents, which are followed by death and injuries of people, along with financial damage.
- Environmental degradation as a result of increase of harmful exhaust emissions.
- Traffic flow speed decrease, which is leading to road congestion.
- Noise has an adverse effect on health of people.
- Vibration causes the destruction of buildings, constructions and roadway.

All the above mentioned has a bad influence on people's health and quality of their lives.

2.2.1 Traffic accidents

Motorization development involves increasing quantity of vehicles and population in road traffic, which leads to an increase in the number of road accidents and severity of their consequences, growth of damage and danger level, characterized by the probability of getting into road traffic accidents, injuries and deaths. . The worst influence on society among the aforesaid factors exerts the road accidents losses.

In 2014, there were 199,700 traffic accidents in the Russian Federation, which killed 26,900 people and injured 278,700 people (Information on indicators of the state of road safety, 2015). Annually road traffic accidents kill 23.5 people per 100,000 population; this rate amounts to 9 - 10 people in the EU countries (Transport strategy of the Russian Federation for the period up to 2030, 2008).

At the same time the projects aimed at providing traffic safety become more complex and require the usage of enormous human and material resources.

There are three important features of modern road transport, determining the low level of security, they are as follows:

- Inadequate availability of roads, meeting the relevant requirements of transport.
- Insufficient isolation of traffic flows from the other road users.
- Driver's low average skill level.

The analysis of the road network development level impact on the accident risk made abundantly clear the correlation between these two factors. The places with the density of road network less than 0.3 km of roads per 1 km² expose dramatically increased major accident rate; it is a number of dead people for 10 thousand vehicles. Whereas the development of the road network must be going with the development of motorization, it can be said that the roads construction is an essential prerequisite for improving road safety (Klinkovshtein & Afanas'ev, 2001).

2.2.2 Road congestion

Traffic jams are one of the most serious problems of traffic in major cities and megalopolises. Due to congestions the speed of traffic is slowed down to 8-10 km / h on some streets at rush hours. This makes inefficient the usage of cars as a means of transportation.

Traffic jams lead to an increase in time spent on travel around the city, especially during rush hours, they also cause the occurrence of mental disorders and neuroses in people staying in them daily, pollute the environment with automobile exhaust gases, increase the level of street noise, interfere with the operational and emergency services. Traffic jams are harmful for private vehicles also, because they conduce to the increase in depreciation and fuel consumption, multiply the risk of emergency situations and traffic accidents.

Permanent road congestions and employees' late attendance associated with jams cause enormous damage to the economy. For example, it was estimated that only City, business center of London, has about a million pounds lost daily because of the tardiness (How to beat tube, 2015).

As for Russia, from 200 to 350 thousand cars are moving in Moscow at weekdays at the same time. The number of cars on city roads exceeds 400 thousand and comes up to 600 thousand at rush hours, and their average speed is about 24 km / h.

Today traffic jams are rated in scores in Moscow and St. Petersburg. Heavy traffic has become invincible phenomenon in those cities and often "Yandex. Traffic" analytical service assesses the situation on a 10-point scale. The rating scale is configured differently for every city; what is a little glitch in Moscow, can be a serious traffic jam in another city. For example, the driver loses the same time moving in 6 scores traffic jam in St. Petersburg and 5 scores jam in Moscow.

A lot of big cities in Russia created websites which help to observe real-time traffic situation in a city and find out the cause of congestion.

2.2.3 Environment degradation

Road transport is the main pollutant of air basin in big cities; its share of total emissions in the country is 40 percent.

Annually, a single car absorbs from the atmosphere more than 4 tons of oxygen in average, while emitting a huge amount of hazardous substances (Ugay & Logvinov, 2013).

About a half of 200 substances formed during the combustion of gasoline are toxic. Carbon and nitrogen oxides, hydrocarbons, aldehydes, sulphur dioxide, lead, chlorine, bromine, phosphorus are among them. These substances adversely affect both on human health and on flora and fauna.

Federal State Statistics Service has published basic rates of environmental emissions of air pollutants from stationary sources and motor vehicles for 2012 . According to these data a list of sixty Russian most polluted cities in terms of total emissions has been compiled (The most polluted cities of Russia for 2013. Top 60, 2015).

We shall say that the list includes only eight out of the ten most motorized Russian cities presented in the Table 2 (see Table 3).

As we can see, in six out of eight aforesaid cities motor transport is the main source of emissions. However, the rate of motorization is not the determining factor of environmental situation. For instance, Vladivostok, the main motorized city in Russia, ranks 48 only in total emissions volume. At the same time Moscow ranks 7 in motorization rate, while it ranks 2 at the list of the worst cities in terms of ecology. By the way, number one in this list is Norilsk, which is not even in the top ten motorized cities in the country.

Table 3. Shares and main sources of emissions

Motorization rank	City	Total emissions rank	Volume of the annual emissions, thousand tons	Main source share	Main source of emissions
1	Vladivostok	48	59.9	59.8%	Motor transport
2	Krasnoyarsk	11	233.8	62.6%	Stationary source
3	Surgut	25	104.9	65.1%	Stationary source
4	Tyumen	39	78.6	70.1%	Motor transport
5	Krasnodar	42	70.5	84.8%	Motor transport
6	Kaliningrad	55	53.9	78.3%	Motor transport
7	Moscow	2	995.4	85.9%	Motor transport
8	Nizhnevartovsk	58	51.2	60.5%	Motor transport

Annual emissions to the atmosphere of Norilsk is 1,959,500 tons; 99.5% accounts for the stationary sources and the major contribution to the pollution belongs to the city-forming enterprise "Norilsk Nickel".

Vladivostok annual emissions amounted to 59.9 thousand tons per year. The main source of air pollution is road transport, which accounts for 59.8% of total emissions. While in Moscow the pollutant emissions make up 995.4 thousand tons, which is almost 16.5 times more than in Vladivostok; and 92.8% of all emissions accounted for road transport. Hence though the motorization rate is not a determining factor, but it exerts a significant effect on the environment of large cities.

Over the past twenty years, the automotive industry has achieved great results in reducing the content of harmful substances in exhaust gases. However the risk that global oil production will not be able to meet the growing demands to the full extent makes the problem of the alternative fuel development essential (Gorbikov, 2014).

The question of recycling of the overage motor vehicles and parts is not less important. Russia has the most time-worn vehicle fleet in Europe. About 50% of all cars in our country are over 10 years. One can find vehicles over 20, 30 or even 40 years old on our roads; hundreds of thousands vehicles get out of the operation every year. Tires, spare parts, exhausted service fluids contain a plenty of environmentally harmful substances. Despite this, car owners, who are not interested to take their old cars in recycling, usually simply landfill them. The reason is that the lack of developed economic instruments does not encourage industry to collect and recycle the old cars, car bodies and automotive components (Volodkin, 2013).

Thus, currently the environmental adverse effect of automobile transport in Russia is a serious problem and it must be addressed.

2.2.4 Noise

In addition to environmental pollution, road transport is also a major source of noise pollution. According to the data of the World Health Organization 60-80% of the population in European countries are exposed to road noise with the day rate about 70-90 dBA, while the normal feature is 55 dBA, i.e. the excess reaches 15-35 dBA (Kompanets et.al., 2012). Directly on the arterial streets of big cities traffic noise runs to 80-85 dBA.

The main factors determining the level of transport noise are as follows:

- Traffic load.
- Share of the noisiest trucks.
- The nature of the roadside area.
- Traffic condition determining the motion mode.

It was found that the noise level increases by 10 dBA approximately with the growth of traffic load up to 1000 automobiles per hour. The noise level largely depends on the traffic speed. It is considered that the increase in traffic speed up to 10 km / h results in noise level growth up to 6 dBA approximately.

According to experts, noise impact is responsible for almost 30% of diseases in the cities. Costs on fighting with noise pollution in developed countries are constantly rising. Annually European Union spends more than 50 billion euros on the noise protection glazing and screen building (Kompanets et.al., 2012).

During the day periods of varying traffic intensity we made the measurements of noise levels in Vladivostok, the most car-dependent city in the country. Measurements were made in the central part of the city. We must say that the share of heavy trucks in the traffic flow is considerable. This is due to the fact that the only way to the port of Vladivostok runs through the center of the city. The measurement showed that the noise level at different time of a day starts from 63 ad comes up to 99 dBA, peaking at lunchtime. Most part of the day the noise level is about 75-85 dBA.

3 Discussion

Ways to reduce the adverse effects of motorization

Every day we face with the negative consequences of motorization. It is impossible to eliminate them in the foreseeable future, so it is very important to minimize their impact on human.

Currently Russia together with the other world is addressing a large-scale consistent work to reduce the negative impact of motorization. A number of measures have already been applied and proved to be successful. In addition, experts are constantly developing new ways to solve traffic problems.

The activities aimed at improving road safety are as follows:

- Promotion of traffic safety rules.
- Driving culture improvement and raising of personal responsibility of the road users.
- Development of a modern system of assistance to victims of road traffic accidents.

- Increased requirements for driver training.
 - Monitoring the violation of traffic regulations, etc.
- Solutions to the problem of traffic congestion are as follows:
- Increase road capacity.
 - Cycling development.
 - Usage of the automated traffic management systems.
 - Charging for entrance and parking in the city center, etc.

To reduce the aversive effects of road transport on the environment the following methods can be applied:

- Using more economy cars.
- Ensuring environmental safety of road transport.
- Improving the quality of fuel.
- Transferring the vehicles to alternative fuel, etc.

The level of traffic noise can be reduced by the following ways:

- The use of anti-noise facilities.
- Decrease in traffic load by the displacement of traffic flows.
- Improvement of the roads design and their rout location, etc.

One of the ways to solve the many problems associated with the growth of the vehicle fleet, is the abandonment of personal transport in favor of public.

Public transport, as well as at the personal, has its advantages, such as:

- 1) It is more cost efficient than personal. The cost of traveling by public transport in Russian cities is about 18-29 rubles that makes public transport the most cost-effective means of achieving urban mobility.
- 2) It provides workplaces and their availability.
- 3) It improves the well-being of cities, increasing the level of security for all social groups and encouraging living a healthier lifestyle.
- 4) It allows improving the environment by reducing vehicle quantity and decreasing the emissions.
- 5) It is the safest means of transportation.
- 6) It helps to put down the traffic load of the road network by reducing the quantity of vehicles, which results in decrease of road congestion. The length of a car is 3.0-4.5 m, and the length of a passenger bus is 8.0-12.0 m in average. Thus, a bus takes 2.5 times more of the road network than the car does. But at the same time passenger bus of a large class can house up to 115 people, while a car often take only 1 or 2 people. Moreover, in case of such unloading of the road network it can be possible to make bike paths.
- 7) Finally, one can read a book or newspaper, and talk on a mobile phone safely during the trip on public transport (Kosyakov, 2014).

Currently, many countries are actively working to improve the competitiveness of public transport. The Japanese prove that waiting for public transport at the city bus stop can be fun and interesting. Japanese designers have located 16 unusual bus stops in the city of Konagai, Nagasaki Prefecture. Being inspired by the principle that a public transport stop is almost a "second home" for many people the

designers tried to make the stops beautiful, bright and original performing them in a mouth-watering fruits and vegetables.

Residents of Germany began to change from private vehicles to public transportation. The reasons are commonplace and familiar to all residents of big cities. It is a lack of free parking spaces and high fuel prices. According to the latest statistics, only one third of the inhabitants of large cities in Germany, regarding the cities with a population of over 500 thousand people, owns their own cars. Others enjoy buses, and the number of "ex automobilists" is growing.

Thus, even now the development of public transport is the main concept of the traffic problems solution in a number of developed countries.

Conclusion

The current imbalance between the rate of the road network development and the growth in the number of vehicles leads to an increase in the accident rate, worsening of traffic conditions, traffic congestions, increased delays and growth of the fuel consumption, environmental degradation, and social discomfort (Pugachev, 2004).

Transport Strategy of the Russian Federation for the period up to 2030 defines the main problems of the transport sector, which includes the following challenges among other issues:

- Insufficient level of traffic safety.
- Strengthening of the transport adverse effect on the environment (Transport strategy of the Russian Federation for the period up to 2030, 2008).

In this regard, a number of indicators of the Transport Strategy implementation is associated with the improvement of safety and ecology of motor transport.

The values of some indicators to be achieved in 2030 in comparison with 2007, when the strategy was approved:

- Social risk of death in road accidents, or a number of deaths per 100 thousand population, is expected to decline from 23.5 in 2007 to 8 in 2030.
- The volume of contaminative harmful substances produced by motor complex is expected to decline by 40%.
- The share of alternative fuels in total fuel consumption is expected to increase from 1% to 35%.

The share of waste recycling in road transport is expected to increase from 50% to 90% (Pugachev, 2004).

The authors are conducting the research in the field of reducing the adverse effects of motorization. Mostly they are aimed at improving traffic management, reduction of accidents and decreasing of congestions. Particularly, we study the influence of the car ownership ratio on the emergency situation in the regions of the country. The measures of reducing the accident risk are also developing.

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