Road safety as a factor in the socio-economic development of the country

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Abstract. In the conditions of modern society, the prospective development of the country's economy cannot be considered without a well-established transport system. The discrepancy between the level of development of the transport network and the level of demand for road transport leads to inefficient and huge costs. The main costs are associated with the elimination of the consequences of road accidents. The article considers road safety as a particularly significant socio-economic problem of the country. The relationship between economic development and the level of road safety was studied using the example of the Republic of Tatarstan (a subject of the Russian Federation). As main indicators we selected population, level of motorization, length of transport networks, gross regional product, accident rates and damage as a result of deadly accidents. Studies have shown that there is an interdependence of road safety and the economy of the republic. Moreover, it is important to assess the direct and indirect socio-economic costs of the consequences of road accidents. This allows us to measure the burden that a traffic accident causes to society, and emphasizes the return on investment in road safety.

1. Introduction

The development of the transport system of any country takes place in a socio-economic context. Transport is an important element of the economy and is one of the general development tools, which means that a large burden is placed on the transport system. The economic development of the country is increasingly linked to the mobility of people, goods and information. Therefore, it can be said that the connection between the quantity and quality of transport networks and the level of economic development is obvious.

The level of development of the transport system of the country is associated with socio-economic indicators as well. The transport system, represented by a highly developed transport network, is efficient and provides great social and economic opportunities. The positive effect will be expressed by better access to production, employment and additional investments for further development. Transport systems that do not have sufficient capacity or reliability contribute to the economic costs that reduce the quality of life. The main costs in this case are associated with the elimination of the consequences of motor vehicle collisions (MVC).
MVC costs undermine the economic well-being of society. It is enough to say that the average age of death in MVC is 20-40 years, i.e. victims are citizens of the most productive age. Economic losses associated only with injuries as a result of MVC, on average, are estimated at 2% of the gross domestic product (GDP) in Europe [1, 2]. According to the Russian Union of Motor Insurers, only the material damage from MVC in Russia is 2.5% of GDP.

Thus, it is possible to designate the mutual influence and interconnection between the country's socio-economic development and road safety.

2. Literature review
The study of the relationship between the socio-economic situation of the country and MVCs is being studied quite actively. The main studies in this area, conducted in various countries, are presented below.

In France, accidents were assessed by three groups of workers: managers, skilled workers and unskilled workers (Lenguerrand et al, 2006) [3].

British scientists compared injuries per 10,000 inhabitants in 15% of the poorest areas and 15% of the richest areas of the Lothian region in Scotland (Abdalla, Barker and Raeside, 1997) [4]. The number of accidents with pedestrians was studied by (Graham, Glaister and Anderson, 2005) [5], which resulted in the development of a negative binomial regression model to explain the number of MVCs.

In Norway, Denstadli and Hjorthol (2002) compared data on the average daily length of travel for people, taking into account their incomes [6].

Studies in Sweden have researched the relationship between socioeconomic variables and the frequency of road traffic injuries (Laflamme and Engstrom, 2002) [7].

We should mention two studies in the United States on the relationship between social status and MVCs. The first study showed that as per capita income increases, death rates among drivers and passengers of motor vehicles decrease sharply. In poor areas, the rate is about 2.5 times higher than in the richest areas. (Baker et al, 1992) [8].

The second American study compared death rates among motor vehicle drivers per million kilometers depending on race and socio-economic status. One of the most interesting findings of the study is that the differences in the level of mortality are partly due to differences in the behavior of drivers. Thus, 42% of men with the highest level of education wore seat belts, compared with only 19% of men with the lowest level of education (Braver, 2003) [9].

Studies of the relationship between various indicators of social status and participation in traffic accidents led to different conclusions. A French study found that people with high social status are more likely to participate in MVC than people with low social status. All other studies have shown that low social status - regardless of how it is measured - is associated with a higher level of participation in traffic accidents. This has been consistently found in studies conducted in the UK, Sweden, Canada, and the United States of America. Thus, the prevalence of evidence suggests that people with low social status are associated with a higher risk of becoming a participant of MVC than people with high social status.

3. The relationship between the transport system and the economy
The economic importance of the transport industry can be assessed from a macroeconomic and microeconomic point of view.

At the macroeconomic level (the importance of transport for the whole economy), the transport and mobility that it provides are linked to the level of production, employment and income within the national economy. In many developed countries, transport accounts for between 6 and 12% of gross domestic product (GDP).

At the microeconomic level (the importance of transportation for certain parts of the economy), transportation is associated with the costs of producer, consumer and production. Thus, the importance of specific transport activities and infrastructure can be assessed for each sector of the economy. Usually,
higher income levels are associated with a greater share of transport in consumption expenditures. Transport accounts for an average of 10% to 15% of the costs of all sectors of the country, while it accounts for about 4% of the cost of each unit of production in production, but this figure varies considerably depending on the industry.

The relationship between the transport system and the country's economy can be formulated as follows [10]:

1) the transport system has a complex effect on the economic development of the region both at the macro level, setting the vector of its development, and in relation to individual firms that determine the use of infrastructure facilities, which is expressed as:
   • providing jobs, generating income for people employed in the country's economy;
   • ensuring the transport availability of resources, production capacity;
   • the spatial development of the country, the involvement and development of new territories, the creation of new jobs, and the development of business in the adjacent territories;
   • formation of budget revenues;
   • reducing the accident rate, the number of road accidents, road congestion, vehicle wear.

2) The country’s economy in turn affects the transport system through the following channels:
   • expansion of labor, material and technical resources for the construction of transport infrastructure facilities;
   • management and regulation of traffic flows;
   • budget investments in transport infrastructure;
   • formation of demand for transport services.

4. The impact of the development of the Republic of Tatarstan on road safety
To empirically confirm the hypothesis of the impact of the country's economic development on the level of road safety, we conducted a study. The main objective of this study is to assess the impact of the transport system on road safety. The study was based on data for the period 1998-2018 for the subject of the Russian Federation - the Republic of Tatarstan.

Indicators of the level of road safety are functions of many variables, and we selected the following as the main ones:

1) socio-economic indicators: population, gross regional product;
2) transport indicators: the length of transport networks, the level of motorization;
3) Accident rates: MVCs, number of injured and dead.

Time series of the presented indicators for the Republic of Tatarstan are shown in Figure 1.
The analysis shows that since 2006, the Republic of Tatarstan demonstrates a growing mismatch between high rates of growth in the number of vehicles and a slow increase in the length of the paved roads network, which accounts for the most of freight and passenger transportation. Peak jumps in the growth of the transport network of the republic are associated with the holding of international events, for which large investments were made in the development of the transport system [11].

One of the most informative indicators of accidents is the social risk (public health risk), taking into account the number of deaths in MVC per 100,000 inhabitants. This indicator can give an objective assessment of the level of traffic safety [12]. Figure 2 shows the relationship between the level of motorization and social risk of the Republic of Tatarstan for the period 1998-2018.

Analysis of the relationship between the level of motorization and the risk of road traffic in the Republic of Tatarstan showed that with an increase in the level of motorization, there is a tendency towards a decrease in the number of people died in MVCs. Figure 2 highlights certain critical points...
characterizing the qualitative changes in the studied relationship between the level of motorization and social risk. Studies have shown that with the growth of motorization, social risk decreases. Moreover, there are transition zones in the range of motorization varying from 250–260 vehicles per 1,000 inhabitants, when the relative death amount gradually moves into a stabilization zone.

A huge role in the formation of accidents is played by a level of development of the transport system. Imbalances in the development of the road network strongly affect the uneven loading of roads, which in turn stimulates the growth of MVC, especially in areas with low traffic capacity and high traffic intensity [13].

The existing shortage of roads has a negative impact on the level of road safety. The risk level of MVCs increases. Figure 3 shows the relationship between the density of roads and social risk of the Republic of Tatarstan for 1998-2018.

The analysis of the presented dependence shows that with an increase in the density of the transport network in the Republic of Tatarstan, there is a gradual decrease in the relative risk of involvement of people in MVCs. With a highway density of 410 km per 1000 km² of territory, we note a decrease in the number of fatalities, which is associated with attracting investment in the transport system in 2011-2012 for the XXVII World Summer Universiade 2013 in Kazan [14, 15]. All this indicates the need for a significant increase in the length of roads in order to reduce the number of MVCs.

The solution to the problem of the shortage of the road network is becoming increasingly important, if we keep in mind the rapid growth in the number of vehicles that is faster than the development of the roads. If we proceed from the number of vehicle fleets, we can conclude that accidents should include not only a deficit in the total length of roads, but also a low technical level of the existing road network and, above all, a shortage of high-grade roads – motorways and high-speed roads with huge capacity [16].

In this regard, in order to develop the road network of the Republic of Tatarstan, and to increase the level of traffic safety as well, it is necessary to increase the length of public roads with hard surface.

The development of the road network is associated with the attraction of huge capital expenditures. Together with the development of the road network, it is also necessary to provide a system of measures to eliminate dangerous sections and increase the capacity of highways. Among the most important tasks - are the measures aimed at reducing the severity of MVCs (installation of barrier fences separating off-
road traffic, construction of elevated and underground pedestrian crossings, road lighting, improving traffic management and other measures that generally reduce accident rates).

Nowadays, road safety management decisions need to be made on the basis of an economic assessment of damage from MVCs. The assessment of damage from MVCs is based on the principles of a planned economy and the laws governing the growth of national income and depends on the size of the gross regional product (GRP) of a country and the number of people employed in the economy [17]. Figure 4 shows the results of the calculation of socio-economic damage from the deaths in the MVCs in the Republic of Tatarstan.

Figure 4. The dynamics of damage from deaths in MVCs in the Republic of Tatarstan.

Based on the analysis of the relationship between the level of motorization and the risk of road traffic (Figure 2) and the socio-economic damage from MVCs in the Republic of Tatarstan, we can assume that with a further increase in vehicles, the number of people affected in MVCs will decrease and the damage will continue to increase.

With the growth of vehicles, other negative consequences will increase. First of all, there will be an increase in the imbalance between the development of the transport network and the level of motorization, and there will also be an increase in the damage caused by the underdevelopment of the transport system. Figure 5 shows the relationship between the density of roads and the damage caused by the deaths in the MVCs in the Republic of Tatarstan for 1998-2018.
Figure 5. The relationship of the density of roads with hard surface with the damage from the deaths in the MVCs of the Republic of Tatarstan (1998-2018).

The analysis shows that having reached the peak density of highways at 410 km per 1000 km² of territory, the damage from loss of life in MVCs decreases. This can be associated with the development of the transport network (which is associated with attracting investments in the transport system in 2011-2012, as mentioned above). Thus, we can say that the development of the transport network of the Republic of Tatarstan contributes to the improvement of road safety. However, it is also necessary to take into account that an increase in the length of the road network in areas with an insufficiently developed network may contribute to an increase in the number of MVCs on them, since in a number of cases they are beginning to assume unusual transportation functions, which contributes to an additional increase in traffic load. In some cases, along with the general improvement of traffic conditions on such roads, there is a known effect of “migration” of MVCs to neighboring areas due to the remaining heterogeneity of traffic conditions, if the reconstruction of road sections was local in nature. In this regard, to ensure the planned level of traffic safety while increasing the length of the road network, the development features and traffic load of the road network should be taken into account, as well as the creation of uniform traffic conditions on each of them in order to uniformly reduce the overall level of observed accidents.

5. Socio-economic efficiency of transport infrastructure development

To improve road safety, it is necessary to reduce the disproportion between the growth of vehicles and the length of the transport networks of the Republic of Tatarstan. Currently, part of the roads in the republic are in a dangerous condition, and considerable funds are required to bring them to proper condition. The relevance of this issue is due to the need to improve road safety, primarily through ensuring the effectiveness of budget expenditures allocated for these purposes.

The socio-economic efficiency of improving road conditions is determined by the impact of the modernization and development of the road network on the costs of road transport and on the demand for road transport. The effects associated with an increase in the speed of vehicles and an increase in the reliability of the year-round traffic on the road network are also taken into account.

Assessment of the socio-economic efficiency of the implementation of measures to improve road conditions can be performed in accordance with the methodology for the phased improvement of transport and operational qualities of roads, which is based on the principle of calculating the transport effect.
According to this methodology, reduction of the cost of road transport is created by lowering the tariffs for the transport of goods and passengers, which in turn affects the cost of goods, works and services. Reducing the cost of production contributes to lower producer prices, which leads to an increase in demand for manufactured goods and services. These factors will lead to an increase in the GRP of the Republic of Tatarstan. A reduction in the transport margin on the goods and services produced leads to an additional (in addition to a decrease in producer prices) decrease in the acquisition prices of goods and services (buyers prices), which further increases the demand for them and the republic's GRP.

The marginal analysis of the profitability of the transport complex reveals the connection between the growth rates of capital investments in the industry and profits. This analysis shows that with the growth of the industry’s capitalization, its profits increase at an accelerated pace, i.e. each additional ruble of investments brings more and more return.

Studies have shown that by 1 rub. invested in the construction of roads, the effect in 5 years will be 3 rub., and with investments in the repair and reconstruction of roads 6 rub. The most effective are investments in measures to ensure road safety: installation of road signs - 27 rubles, lighting of road sections - 12 rubles, installation of barrier fences - 11 rubles etc.

Thus, investments in highways have a significant positive effect on the macroeconomic indicators and the growth rate of the country's economy.

6. Conclusion
Improving road safety is one of the priorities of the country's economy. This situation is caused, first of all, by economic necessity, since movement by means of transport is designed to minimize the time costs, which is a criterion of efficiency from the standpoint of modern human. The improvement and development of transport networks contributes to the mobility of labor, goods and resources, the expansion of trade relations and increased competitiveness and accessibility of economic regions. All this together determines the need to modernize the transport network to improve road safety.

Studies show that there is a relationship between a country's economic development and road safety, as measured by the number of MVCs. Economic changes in the development of the country have a direct impact on the level of motorization, transport risk, the number of MVCs. In this situation, it is necessary to clearly formulate goals for road safety and, in particular, to set quantitative goals.

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