Assessment of the impact of transport energy costs on the efficiency of public-private partnership projects

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Abstract. The subject of ensuring the efficiency of public-private partnership projects in the road industry in terms of fuel consumption by vehicles is considered. It is concluded that the valuation of transport energy costs has a significant impact on the efficiency of projects. It is noted that the budget, commercial, and social efficiency of projects will significantly depend on the value of transport energy costs. Using the example of one of the road sections, the structure of economic effect for users is determined. The current trends in the development of innovative transport in Russia (the use of electric vehicles, self-driving vehicles, gas engine vehicles) are considered, and the possible impact of the use of such vehicles on project efficiency is determined. It is noted that the main indicators that determine the efficiency of projects (demand, competitiveness, tariff policy, revenue stream and others) will be affected. The value of this impact will largely be determined by the response of users who will adapt to changing conditions. Possible strategies for adaptation of users in the context of large-scale introduction of innovative transport into the economy: increased or decreased car use, change of departure time, use of alternative routes, switching to other modes of transport, etc. Accounting for this change in behavior is necessary to ensure the efficiency of public-private partnership projects in the road industry.

1 Introduction

Over the past decade, in the context of growing uncertainty in economic development in Russia, various forms of public-private partnership (PPP) have acquired particular importance in the implementation of important (from a social point of view) infrastructure projects. This is consistent with the current task noted by many politicians and scientists, who note that in the modern paradigm, the priority development of infrastructure compared to other areas of development is a priority [1]. Under current conditions, it is necessary to increase the efficiency of public-private partnership projects for the main stakeholders: the state, business, and the public. The search for a balance between their interests is also necessary: a balance between commercial, socio-economic, budgetary, national economic, and regional efficiency of projects [2, 3]. Efficiency issues are important for road industry.

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The development of the road industry in Russia throughout the entire period of the state's existence is a widely discussed area at the level of the government, the public, and the scientific community. The country's road industry is a large-scale, multi-level system with a complex set of targeted areas for its development. The need for investments in the road sector of Russia is extremely high and only increases every year. At the same time, despite the importance and necessity of investment in the road network of the country, it continues to be funded on a residual basis. The study of statistical indicators suggests that road transport continues to play a leading role in the system of transportation of both goods and passengers. This circumstance attaches great importance to the development of road industry, which is the infrastructure support for road transport. Phenomena occurring in recent years enter into dissonance with the needs of the development of road industry. Funding volumes are decreasing, there is a refusal to implement certain projects due to a general lack of funds in the country's economy. Public-private partnership projects are beginning to play an increasingly significant role.

In the road industry in Russia, the process of introducing public-private partnership mechanisms is rather difficult. After the adoption of the Federal Law "On Concession Agreements" [4], the first projects in the road industry were generally unsuccessful. The process of concluding contracts proceeded very hard, there were constant coordination and refinement. At present, the texts of concession agreements are not publicly available. The same applies to the West High Speed Diameter (WHSD) projects that are currently underway and the "Platon" toll system. Among the disadvantages of the development of the concession mechanism in the road industry, it is necessary to note the lack of transparency in holding tenders, the secrecy of information about projects, the lack of public access to the texts of concession agreements, etc. As a result, the conducted assessments show that the conditions created at the present time do not allow implementing sufficient number of projects in the road industry [5]. This largely applies to issues of project efficiency. Often projects are implemented without sufficiently considering efficiency issues. Possible types of efficiency in the implementation of public-private partnership projects in the road industry are [6; 7]: budget, commercial, economic, environmental, social and others. All these types of effects are discussed in detail in the scientific literature. At the same time, the issues of impact on these types of fuel and oil consumption efficiency (first of all, fuel) have not been adequately studied. Meanwhile, the valuation of transport energy costs can have a significant impact on the efficiency of public-private partnership projects in the road industry.

2 Materials and methods

The implementation of public-private partnership projects in the road industry involves the construction or reconstruction of the automotive infrastructure, which allows improving the conditions of movement for the traffic flow and has an effect for users. The effect value is calculated on the basis of a comparison with the situation before the project implementation, i.e. on the basis of a comparison with the transport and operational characteristics of the road before and after work in the case of reconstruction, repair and major repairs. In the case of new construction, the transport and operational characteristics of the roads used for making trips before the project implementation should be taken as a base for comparison. Also, in Russia, effects for a traffic flow are calculated relative to an alternative free route. In general, the following effects may occur, which are subject to economic assessment [8-10]:

$$E_{.} = E_1 + E_2 + E_3 + E_4 + E_5 + E_6 \quad (1)$$

Where:

E_1 – effects of increasing the speed of traffic;

E_2– effects of reducing unproductive time losses of the population;
E_3– effect of reducing the negative environmental impact of the road;
E_4– effect of increasing the road safety;
E_5– effect of reducing energy consumption for the operation of the vehicle;
E_6– other types of effects for which valuation is possible.

One of the main types of effect is the reduction of transport energy costs, which can have a significant impact on various types of efficiency of public-private partnership projects in the road industry - Figure 1.

Fuel consumption can have an impact on various types of project efficiency. Lower fuel consumption, for example, has a significant impact on the choice of a route by a user, largely determining the demand for the service. Also, the impact is on the budget sphere of the country, which in terms of income is interested in the growth of transport energy costs. In modern conditions, the task of determining the impact of transport energy costs on the efficiency of PPP projects in the road industry should take into account the development of electric transport and gas-engine vehicles, the use of self-driving vehicles. These aspects can significantly affect the efficiency of projects.

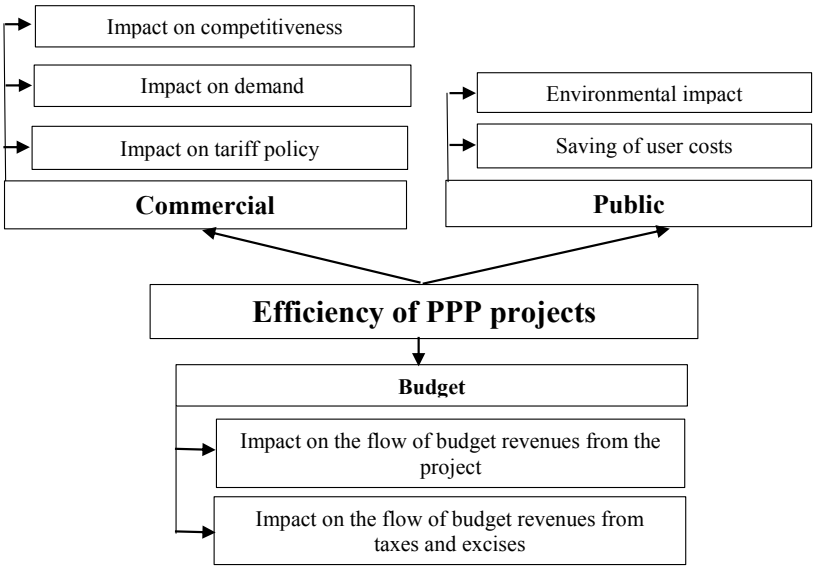

Fig. 1. The impact of transport energy costs on the efficiency of PPP projects in the road industry.

3 Results

Based on the presented approach for the M-4 "Don" highway, the effect was calculated for users regarding an alternative free route. The structure of the effect is shown in Figure 2. It used a vehicle classification modified with respect to the current regulatory document - Table 1.

The data obtained allow us to conclude that the saving of transport energy costs is a significant amount in the total effect size. This is especially true for the first 3 groups of vehicles, where this value is about 35-40% of the total effect. In addition, this approach does not take into account the above-mentioned current trends stipulated in the development program of the Federal Road Agency "Rosavtodor" [11].

Table 1. Modified classification of vehicles.

Vehicle group	Vehicle type
G_1	Motorcycles with and without trailer (sidecar), cars with and without trailer, vans
G_2	Trucks, vans
G_3	Trucks, trailers
G_4	Trucks, trailers, special large vehicles
G_5	Buses

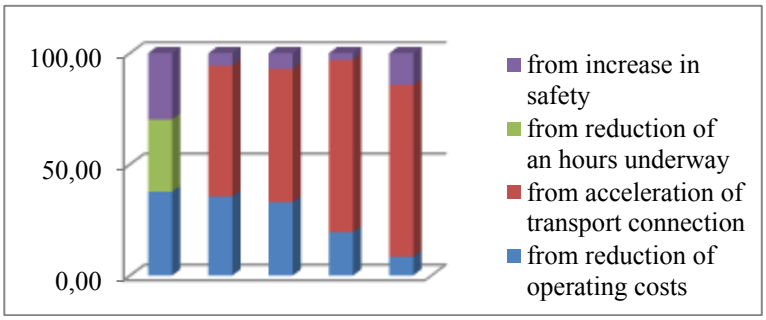

Fig. 2. The structure of the effect of users of different groups for the section of the M-4 "Don" highway.

Fig. 3 shows the current trends in the development of innovative transport in Russia.

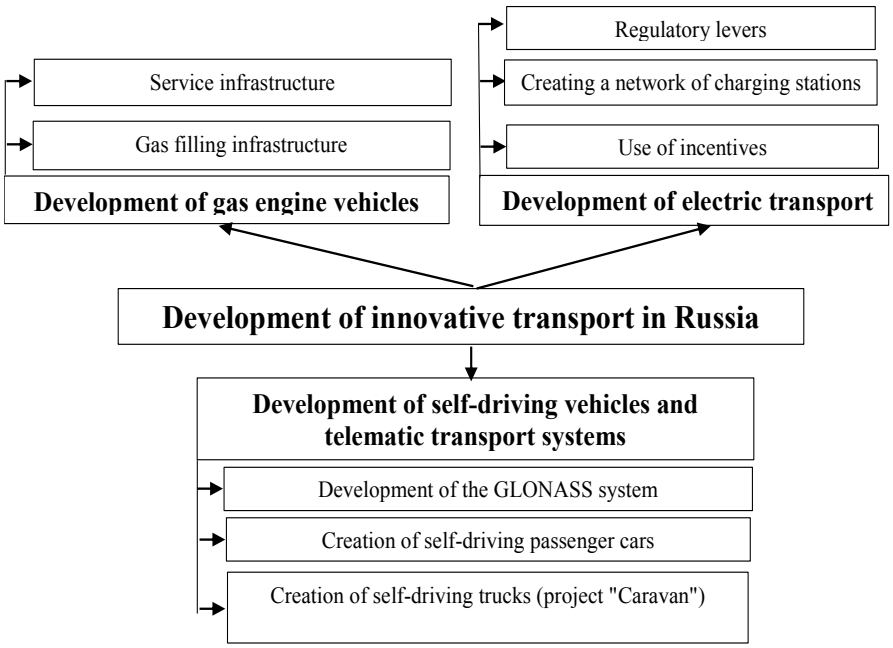

Fig. 3. Development of innovative transport in Russia.

These trends can have a significant impact on the efficiency of public-private partnership projects. Thus, the calculations for different categories of vehicles show that when using gas fuel as fuel for vehicle groups presented in Table 1 for the considered section of the highway, the share of effects from lowering operating costs decreases from 35–40% to 20–25%, depending on the category of vehicles. And for electric vehicles, this decrease is even more significant (up to 5-10%). Thus, for owners of such cars, the value of the effect will be much lower, which can have a significant impact on the choice of route. The use of self-driving vehicles and their impact on the efficiency of PPP projects is a separate complex task, and its relevance will increase when conditions for large-scale use of such vehicles (legislative, technical, infrastructure and others) will be created in Russia. For users with self-driving vehicles, such indicators as, for example, the value of time will require additional assessment.

4 Discussion

Currently, the functioning of toll roads on the principles of public-private partnership in Russia does not have a sufficient scientific and regulatory framework. In particular, the existing method of determining the fare [12] does not meet the requirements of modern conditions. A number of necessary documents are missing, including those that allow determining the effect of freight transport on the road's carrying capacity, the destruction of the roadway, and the expenses of the management organization for maintaining the facility. One of the insufficiently developed issues is the assessment of the impact of transport energy costs on the efficiency of projects in the context of the introduction of innovative modes of transport.

The approaches presented in this paper to determine the impact of transport energy costs on the efficiency of road industry projects implemented by the principles of public-private partnership, of course, require their development. Certain aspects, such as determining the demand for driving along a toll road in the case of mass use of electric vehicles or self-driving vehicles require a much in-depthanalysis. It is necessary to take into account a variety of factors that influence decision making, as well as the multiplicity of impacts on project efficiency. This becomes significant in the long run. One of the central moments will be the adaptation of users to new conditions. Possible strategies for adaptation of users in the context of large-scale introduction of innovative transport into the economy: increased or decreased car use, change of departure time, use of alternative routes, switching to other modes of transport, etc. These decisions will depend not only on the rational economic calculation but will also affect a number of complex psychological issues, therefore the feasibility of projects will be largely determined by the response of the population. All this requires further work on the presented topics.

5 Conclusions

The successful feasibility of public-private partnership projects in the construction of toll roads is largely determined by the effects on users that they receive as a result of driving along high-quality road infrastructure. In this structure, transport energy costs havea significant share. They largely have a significant impact on demand, competitiveness, tariff policy and, as a result, on various types of project efficiency. In the context of the introduction of innovative modes of transport in the Russian economy, it is necessary to modernize the assessment system of effects for users of such vehicles. This will help forming the necessary basis for ensuring the efficiency of projects and finding a balance between different types of efficiency. The results of the study presented in this paper allow

us to conclude that the use of innovative types of transport in Russia will significantly change the value of the effect for users, which will affect demand, the fare rate, and a number of other important indicators of public-private partnership projects.

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