Improving the Safety of Transportation by School Buses

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Abstract. The research problem is relevant due to the fact that for several years in the Russian Federation accident rate involving school buses remains high. The article is aimed at defining new approaches to the organization of transportation of students in order to improve the safety of such transportation. The leading approach to the research of this problem is the analysis of domestic and foreign systems of the organization of transportation of school students which detected that the high level of safety is provided in case if transportation is carried out by road transport operators. In this regard, the authors propose to select road transport operators using the mechanism of public procurement based on the evaluation of the conditions of the organization of the transportation process. The article provides the argumentation of the indicator of the level of ensuring the safety of transportation of school students, which depends on the conditions of the organization of the transportation process: the state of the material and technical resources, human resources, organization and management of the transportation process, the organizational management to ensure the safety of the transportation process and the financial support of the road transport operator.

1. Introduction
At present in the Russian Federation there is a system of transportation of school students by buses assigned to educational institutions. Transportation is carried out on a regular basis, according to established routes and schedules. However, the legal acts do not provide the concept of "school transportation", there are no special requirements for such transportation, so they are carried out in accordance with the rules of organized transportation of groups of children by buses. Educational institutions, which organize the whole process of transportation on their own, do not have the necessary material and technical resources and qualified staff.

As a result of the existing approach to the organization of transportations are numerous violations of the transport legislation identified during inspections of schools, and a high level of accidents.

2. The problem of transportation safety of school students in the Russian Federation
According to modern explanatory dictionaries, a school student is a student of elementary or middle school. In this case, we also include in this meaning students of gymnasiums and lyceums. Thus, the transportation of school students should be understood as transportation of students of comprehensive schools.
In five years (from 2012 to 2016) there were 68 road traffic accidents involving school buses in our country, where three children died and 161 children were injured.

The analysis showed that in five years more than a third of accidents were caused by school bus driver’s fault, by vehicle malfunction or by violation of the rules of organized transportation of groups of children by buses [1-5].

A number of works of Russian researchers are devoted to the problems in the field of organization and safety of transportation of school students.

Based on the conducted analysis of domestic system of transportations of school students the team of authors [6] draws a conclusion about the absence of the school students transportation system at all. The authors note that still there is no approved concept of "school transportation" at the legislative level in Russia. In other works of these researchers [7, 8] problems connected with safety of transportations of school students, as well as organizational, technological and economic problems are noted besides legislative problems.

Based on the analysis of problems in the field of transportation of school students the authors [9-11] conclude that most of the existing problems are caused by the fact that buses are assigned to educational institutions.

The team of authors [12, 13] considers improving the safety of transportation of school students as one of the ways of reducing child road traffic injuries in the Russian Federation.

Most of the authors of the analyzed works agree that the problems in the field of transportation of school students, with the low level of security as the main problem, are connected with the absence of a professional approach to the organization of transportation. This is confirmed by the Concept of organizing the transportation of groups of children by buses adopted in 2016, according to which road traffic accidents of organized groups of children occur mainly because of the imperfection of management and control over the organization of the transportation process [14].

The measures specified by the Concept are aimed at solving existing problems and improving the transport of organized groups of children by buses, including school buses. One of the priority measures is the creation of specialized enterprises for organized transportation of groups of children by buses, including school transportation [14].

The solution of problems in the field of transportation of school students therefore requires a providing of a professional approach to the organization of transportation by creating specialized organizations or involving existing passenger transport enterprises. At the same time, the enterprise must ensure a high level of quality, and mainly, the safety of transportation of school students. In this regard, it is necessary to develop an indicator that will assess the level of safety of transportation of school students by a particular carrier.

3. Theoretical background of the school students transportation safety level indicator
A number of Russian and foreign authors have proposed approaches to the research and assessment of the level of quality of passenger transportation.

In order to evaluate the quality of passenger’s transportation in terms of safety the authors [15] propose to use the passengers transportation safety level indicator, which is characterized by indicators of the level of protection of passengers from the conditions of occurrence of traffic accidents and acts of illegal interference.

An enterprise which is engaged in the transportation of school students, must also ensure the protection of students from the conditions of occurrence of traffic accidents and acts of illegal interference.

According to the requirements of normative legal acts in the field of passengers motor vehicle transportation safety and transportation of children, and also according to the existing scientific approaches to definition of the passengers transportation safety indicator [15-19] the complex of measures carrying out at the motor transport enterprise which allows to provide school students transportation safety on all components is defined.
This complex includes the following measures to comply with legal requirements of the carrier in the field of road safety and transport safety:

– provision of professional selection and training of drivers;
– carrying out obligatory medical examinations of drivers, actions taken to improve drivers skills in pre-medical care of the victims in traffic accidents;
– compliance with the drivers work-rest regime;
– holding transportation safety orientations for drivers;
– internships for drivers;
– analysis and elimination of the causes of road accidents and traffic violations;
– ensuring professional selection and training of workers directly connected with the vehicles transportation and ensuring their compliance with professional and qualification requirements.
– ensuring compliance of vehicles with the requirements of the technical regulation legislation of the Russian Federation;
– ensuring the appropriate technical condition of vehicles to the road safety requirements;
– ensuring pre-trip and post-trip inspection of the technical condition of vehicles;
– equipping vehicles with tachographs;
– providing execution of the duty of vehicles owners on insurance of civil liability and carrying out technical inspections of vehicles;
– providing equipment of vehicles in accordance with the requirements;
– compliance with the requirements for the sanitary conditions of vehicles;
– traffic monitoring using GLONASS system;
– ensuring safe transport conditions, including compliance with the rules of transportation of groups of children by buses;
– preparation and updates of plans of ensuring transport safety;
– clear regulations of actions during acts of illegal intervention and actions for the prevention and elimination (minimization) of their consequences;
– good performance of warning systems during acts of illegal interference;
– providing vehicles Parking (storage) eliminating unauthorized access to vehicles, and also unauthorized usage by drivers.

In its turn, the implementation and effectiveness of the measures mentioned above is determined by the state of the carrier resources and the effectiveness of the organization and ensuring safety of the transportation process, and depends on the following factors:

– conditions of the material and technical resources (PMTR);
– human resources (PHR);
– organization and management of transportation process (POMT);
– organization of ensuring the transportation safety (POTS);
– financial support (PFS).

In this regard, the level of transportation safety can be represented as:

\[ S^e = f(P_{MTR}, P_{HR}, P_{OMT}, P_{OTS}, P_{FS}). \]  

The authors developed a method of selecting a passenger transport enterprise for transportation of school students in municipal areas using the mechanism of public procurement. According to the current legislation, the cost and non-cost evaluation criteria should be taken into account in the competition for the provision of services.

The non-cost criteria reflect the status of all the five components of the passenger transport enterprise. Therefore, the evaluation of the bidder on non-cost criteria is a function of these parameters:

\[ K_{\text{non-cost}} = f(P_{MTR}, P_{HR}, P_{OMT}, P_{OTS}, P_{FS}). \]  

Thus, the evaluation of the proposal of the bidder on non-cost criteria \( K_{\text{non-cost}} \) will allow you to assess the level of student transport safety of a particular carrier and can be represented as follows:
The indicator of the school students transportation safety level by a particular carrier can be quantified using non-cost criteria of a competitive selection:

\[ S^S = \sum_{i=1}^{n} (K_i; C_i). \]  

where \( K_i \) – is the evaluation of the proposal of the bidder for the i-th non-cost criteria; \( C_i \) – is a measure of the importance of the non-cost criteria evaluation of the proposal of the bidder; \( n \) – is the number of non-cost criteria.

The level of school students transportation safety in a given territory (for example, in the region) depends on the level of security provided by independent carriers engaged in transportation in municipal areas:

\[ S^S = \sum_{j=1}^{m} \left[ \| \cdot \|_j \cdot S^Q_j, \right] \]  

where \( \| \cdot \|_j \) – weighting factor that takes into account the number of buses of the j-th carrier; \( S^Q_j \) – the level of school students transportation safety by j-m carrier; \( m \) – the number of carriers engaged in the transportation of school students in the study area.

This indicator can be used to determine the average level of school students transportation safety by several carriers.

Weighting factor that takes into account the number of buses of the j-th carrier

\[ \| \cdot \|_j = \frac{A_j}{A_V}, \]  

where \( A_j \) – is the number of vehicles for school students transportation of the j-th carrier; \( A_V \) – is the total number of vehicles engaged in the transportation of school students in the study area.

### 4. The results of experimental studies of the school students transportation safety level

The authors developed criteria and indicators for competitive selection, which allows to assess the conditions of the organization of the transportation process. In the course of the experimental study, the criteria and indicators in five passenger motor transport enterprises (PMTE) and in five schools (S) of Primorskiy Region were determined, and then, by the formula (4), an indicator of the level of ensuring the safety of transportation of school students was calculated (figure 1).

![Figure 1. School students transportation safety level in passenger transport enterprises and schools of Primorskiy Region.](image_url)
Taking into account the number of vehicles carriers possess we have defined the average level of ensuring the safety of transportation of school students by several carriers. The results of the study led to the conclusion that with the involvement of passenger motor transport enterprises in the school transportation system the school students transportation safety level indicator in the territory of Primorskiy Region, will increase on average from 0.504 to 0.764.

5. Conclusion
The school students transportation safety level indicator offered in the article promotes realization of the measures provided by the Concept of the organization of transportation of groups of children by buses, and can be used in the selection of the passenger motor transport enterprise for school students transportations in municipal areas.

Improving the safety of transportation of school students is one of the ways to reduce child road traffic injuries. In turn, reducing accidents involving children is one of the objectives of the Federal target program “Improving road safety in 2013-2020” [20]. Thus, the research of the authors is aimed at solving the state problems of the Russian Federation.

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