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Research Paper

Evaluation of motor transport legislation impact on passenger transportation safety

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Abstract

The article describes the issues regarding organization of passenger motor transport work. The purpose of the research was set, which consists in elaboration of theoretical and methodological regulations for safety assessment of motor transport legislation affecting passenger transportation. The description of theoretical and methodological instruments for assessment of motor transport legislation effect on passenger transportation safety was presented. Multi-level structure of motor transport legislation, resulting in excessive, not always efficient, variety of motor transport activities regulation, was shown. The analysis of regulation of organizational and functional structure indicators of transporters in motor transport legislation of regions' located in the territory of Volga Federal District as of 2014 was carried out. The analysis of breakdown rate indicators was performed in passenger transport for the same period. Correlation analysis of those groups' indicators was conducted. The obtained results indicate the existence of moderate negative relation between those groups' indicators. An important scientific and practical task was solved, which consists in assessment of motor transport legislation affecting passenger transportation safety. It was ascertained that one of methods for managing the safety of passenger transportation by motor transport is regulation of organizational and functional structure of the transporters. The theoretical and methodological instruments were developed to purposefully improve the organization of and technology of passenger transportation by motor transport. There was an assumption made that an optimization of regulated requirements structure would eventually facilitate increase of safety of passenger transportation by motor transport. It was recommended to apply the results of this work in the course of transport legislation elaboration. There was the summary formulated. The conclusion of aim achievement and research hypothesis validity was made.

Keywords: *Transport; Legislation; Structure; Safety*.

1. Introduction

The condition of the passenger motor transport mainly determines the country's development level, the level of citizens' rights and freedomsenforcement. Along with that, this type of transport is the source of the major risk for a person and environment. It is necessary to manage the passenger transportation efficiently, which is significantly complicated by the industry decentralization in the Russian Federation. And here the situation can be managed in accordance with the regulations of the motor transport legislation governing the organization and technology of transport activities and being concentrated at the federal, regional and municipal levels. This multilayered system led to the enormous variety of motor transport regulations, while the safety is still at the low level.

Many studies [1-9] are devoted to the issue of regulating the procedure and organizing the motor transport activity aimed at maintaining good quality of transportation services. These works are focused on the methodology to evaluate the quality of transportation, management model together with contract-based and tariff-based transport policy, state regulation. A great number of studies evidence for the problem being highly relevant both in Russia, and in the European Union, as well as in the countries of Northern America. Some papers [10], [11] consider the efficiency of the legislation regulation in different spheres of activity. However, the task to improve the quality, including, first of all, the safety of the passengers being transported by the motor vehicles, on the basis of legislation improvement, was notregarded in the literature known to the authors. The present paper is aimed to fill this gap.

The purpose of the research is to develop theoretical methodological provisions to evaluate the impact of motor transport legislation on the safety of passenger transportation.

Scientific approach is based on the theory of transport processes, theory of qualimetry and quality management with due regard to peculiarities of motor transport, mathematical statistics.

The hypothesis of the research is the impact of carrier's organizational functional structure regulated by the regional motor transport legislation on the safety of transportation process.

2. Materials and methods

The studies [12, 13] developing the provisions of the qualimetry theory and quality management are the theoretical basis for this evaluation. It consists in the fact that the quality of the passenger transportation, with the safety being one of the main provisions, is illustrated by a model (1). The generalized quality indicator Z_0 characterizes the satisfaction of the passengers with the motor transport process and is based on the local indicators Z_i of the quality:

$$Z0=F\ (z_{11};\ Z_{12}\ldots;Z_i) \le Z_0 \le 1Z_0 \to 1 \qquad (1)$$

To achieve the required quality, a passenger carrier must have an organizational functional structure C_0 with its elements C_j being able to provide the fulfillment of the requirements of the quality, first of all for the safety, of the transportation process. Mathemati-

cally, the organizational functional structure can be expressed as follows (2).

$$\text{Objective function } C_0 \rightarrow 1 \quad (2)$$

whereV_j is the weighting factor for the influence of the elements $C_j$in the functional organization on the transportation quality.

$$VI=\sum \alpha_j^n.\delta_h.\rho_g \quad (3)$$

Whereαj is the rate of organizational functional structure ij-indicator influence on the first level quality indicator h;
δ_h is the quality indicator h influence on a group of second level quality indicators;
ρ_g is the influence rate of indicator group on the generalized third level quality indicator Z_0 where g is the number of indicator group.
Indicator Z_0 is connected with the indicators C_j of the transportation carriers' organizational functional structure via a dependence (4):

$$Z0=\sum VjCj;\sum Vj=1 \quad (4)$$

The indicator C_j in the carrier's organizational functional structure takes the value of 1 in its application, otherwise it takes 0 value (absent in the structure).
Carrier's functional organization (Fig.1) is a complicated system defined by the rules, carriers' duties in accordance with the regulatory and technical guidance documents of different hierarchy, and consists of three parts (5).

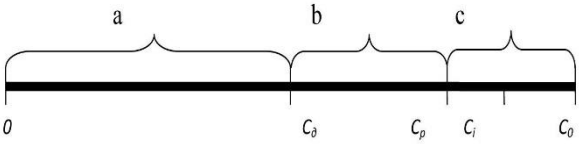

Fig. 1: Conventional Linear Scale of Carrier's Organizational Functional Structure Determining the Quality of the Transportation Process.

The first part (a) is defined by the federal level rules regulating the safety of the transportation process, key provisions of the transportation organization, interaction of the main participants in the process. The second part (b) specifies general but other norms at the federal level in the regulating documents of the regional level. The third part (c) is voluntary in nature due to some restrictions set by the federal legislation, for example, anti-monopoly legislation, but stimulates the carrier to fulfill them by benefiting with an access to the transportation process. The development of the second and third parts is within the competency area of the regional authorities.

$$C_0=a+b+c; \text{ or } V_a \cdot C_a + V_b \cdot C_b + V_c \cdot C_c ; \quad (5)$$

Where $V_a \cdot C_a$ are the $C_a$elements of organizational functional structure and their weighting coefficients $V_a$of influence on the transportation quality according to the passengers' requirements determined by the federal legislation?
nis the number of the carrier's functional organization elements for a part "0-C_d", units;
$V_b \cdot C_b$ are theC_b elementsof functional organization and their weighting coefficients $V_b$of influence on the transportation quality in accordance with the passengers' requirements determined by the regional legislation specifying the federal level norms;
тis the number of carrier's functional organization elements for a part "C_d - C_p", units;
$V_c \cdot C_c$ Are the $C_c$elements of functional organization and their weighting coefficients V_c of influence on the transportation quality according to the passengers' requirements.
$V_c \cdot C_c$ Are the $C_c$elements of functional organization structure and their weighting coefficients V_c of influence on the transportation quality according to the passengers' requirements defined by the regional legislation and motivating the carrier;
kis the number of carrier's functional organization elements for "C_p- C_0" units;
Mathematical model of generalized quality indicator Z_0 is as follows:

$$Z_0=0,03C_{3211}+0,041C_{3212}+0,062C_{3213}+0,071C_{3214}+0,05C_{3221}+ +0,041C_{3222}+0,038C_{221}+0,057C_{222}+0,057C_{223}+0,004C_{224}+ +0,055C_{225}+0,052C_{226}+0,054C_{227}+0,044C_{231}+0,039C_{232} +0,056C_{233}+0,016C_{241}+0,043C_{242}+0,022C_{243}+0,049C_{244}+ +0,012C_{245}+0,042C_{246}+0,019C_{247}+0,032C_{248}+0,014C_{249},.$$

where subsystems of the carrier's organizational functional structure: C_{3211} is the instructions and job training for the drivers; C_{3212} is the mastery and experience of the drivers;C_{3213} is the following the labor and rest regime of the drivers;C_{3214} is the pre-trip and post-trip medical check-ups of the drivers;C_{3221} is the basic education of the top managers, chief automobile profile specialists, experience in the industry; C_{3222} is the qualification advancements for the engineering technical personnel; C_{221} is the evaluation of the production technical base for the technical maintenance and repair of the vehicles via certification method; C_{222} is the provision for the technical maintenance of the vehicles on a regular basis; C_{223} is the provision of the gear, equipment and condition for the vehicles in accordance with the safety requirements; C_{224} is the provision for the equipment to transport the disabled passengers; C_{225} is the provision for the pre-trip and post-trip technical maintenance of the vehicles; C_{226} is the provision to confirm the conformity in introducing the changes in the transport vehicle construction; C_{227} is the provision for the comfort of the passenger transportation, including the sanitary condition of the vehicles; C_{231} is the monitoring of the safe condition of regular transportation routes; C_{232} is the monitoring of the traffic safety with GLONASS; C_{233} is the prevention of the unsanctioned access to the vehicles in inter-shift storage; C_{241} is the transportation planning; C_{242} is the evaluation of the transportation organization conformity by certification; C_{243} is the passenger traffic monitoring at the routes; C_{244} is the provision of the conformity for the traffic types, route types, categories and classes of the vehicles; C_{245} is the prompt management (dispatching) of the transportation; C_{246} is the documentation for the transportation process; C_{247} is the provision of the carrier's responsibility insurance; C_{248} is the information support of the transportation process;C_{249} is the organization of modern non-cash payment for transportation.
Equation (5) evaluates the influence of the motor transport legislation on the passenger transportation safety. The object for the evaluation is the legislation regulating the organizational functional structure of the carriers in the regions on the territories of Volga FederalDistrict. Legislation [14-20] was evaluated as of 2014. This year was chosen due to the fact that the regional regulatory acts within the existing federal legislation had been completely developed. The same year was evaluated from the point of the vehicle accidents involving the passenger motor transport with the bus drivers of the carriers with the license for the transportation activity in each region. Experimentally, this was the task to find the relation between the values of the generalized quality indicator Z_{0i}determined by the regulated requirements for the organizational functional structure of the carriers and accident indicators in each region.

3. Results

Table 1 exemplifies the calculation of the values of the generalized quality indicator Z_{0i} for the Republic of Tatar Stan.
The value of the generalized quality indicator Z0i in the Republic of Tatarstan was 0.851 with due regard to the requirements of the federal legislation (part a). The values of the generalized quality indicatorZ0i (Table 2) were found in the similarly for the remaining subjects in Vol-ga Federal District. An average indicator val-

ueZ0i for Volga Federal District was 0.771. Table 3 illustrates the indicators for the accidents with carriers' buses licensedfor the transportation activity in VFD in 2014 and their conse-quences. With regard to different levels of the social economic development in the regions, further research is related with some specific indicators: correlation between the number of the road traffic accidents (RTA) and the number of the licensed buses; correlation between the number of the injured in RTA and the number of the licensed buses.

Table 1: Calculation of the Values of the Generalized Quality Indica-Tor Z0i for the Republic of Tatarstan

No.	Indicator of organizational functional structure	Indicator type (a, b,c)	Weightingcoefficientofindicator	Presence (absence) of a subsystem (yes, no)	Weighting coefficient value with the requirements to the indicator
1	C3211	a	0.03	no	0
2	C3212	a	0.041	yes	0.041
3	C3213	a	0.062	yes	0.062
4	C3214	a	0.071	yes	0.071
5	C3221	c	0.05	yes	0.05
6	C3222	a	0.041	no	0
7	C221	c	0.038	no	0
8	C222	a	0.057	yes	0.057
9	C223	a	0.057	yes	0.057
10	C224	c	0.004	yes	0.004
11	C225	a	0.055	yes	0.055
12	C226	a	0.052	no	0.052
13	C227	c	0.054	yes	0.054
14	C231	a	0.044	yes	0.044
15	C232	c	0.039	no	0
16	C233	b	0.056	no	0
17	C241	a	0.016	yes	0.016
18	C242	a	0.043	no	0
19	C243	b	0.022	yes	0.022
20	C244	b	0.049	yes	0.049
21	C245	b	0.012	yes	0.012
22	C246	a	0.042	yes	0.042
23	C247	a	0.019	no	0
24	C248	a	0.032	yes	0.032
25	C249	c	0.014	no	0
	Indicator Z0 in the Repub-lic of Tatarstan	a+b+c=1 a=0.662	1		0.853

Table 2: Values of the Generalized Quality Indicators Z_{0i} for the Subjects of Volga Federal District

Z_{0i}indicator	VFD Subject	indicatorZ_{0i}	VFD Subject
0.743	SaratovOblast	1	OrenburgOblast
0.74	UlyanovskOblast	0.877	The RepublicofBashkortostan
0.714	NizhnyNovgorodOblast	0.851	TheRepublicofTatarstan
0.694	KirovOblast	0.888	Udmurtia
0.682	The ChuvashRepublic	0.797	MariyElRepublic
0.662	PenzaOblast	0.748	SamaraOblast
0.662	PermKrai	0.743	The RepublicofMordovia

Table 3: Indicators for the Accidents with Carriers' Buses Licensed for the Transportation Activity in VFD in 2014 and their Consequences.

RF subject	Numberof RTA	Number of RTA fatali-ties, per-sons	Number of RTA injured, persons	Number of RTA suf-fered, persons	Number of the licensed buses in a RF subject	Ratio of RTA number to the num-ber of the licensed buses	Ratio of the RTA injuried to the number of the li-censed buses	Value of the generelized quality indicator Z_{0i} in a RF subject
The RepublicofBashkor-tostan	27	2	48	50	21686	0.0012	0.0023	0.877
The MariyElRepublic	12	1	37	38	1696	0.0071	0.0224	0.797
The RepublicofMordovia	13	1	20	21	2769	0.0047	0.0076	0.743
TheRepublicofTatarstan	47	1	68	69	13702	0.0034	0.0050	0.851
The UdmurtRepublic	21	2	21	23	2520	0.0083	0.0091	0.888
The ChuvashRepublic	81	4	114	118	2586	0.0313	0.0456	0.682
PermKrai	91	3	132	135	8832	0.0103	0.0153	0.66
KirovOblast	25	0	29	29	2630	0.0095	0.0110	0.694
NizhnyNovgorodOblast	112	8	182	190	6477	0.0173	0.0293	0.714
OrenburgOblast	23	1	34	35	10644	0.0022	0.0033	0.998
PenzaOblast	80	3	122	125	3938	0.0203	0.0317	0.66
SamaraOblast	78	1	117	118	13128	0.0059	0.0090	0.748
SaratovOblast	57	1	85	86	11352	0.0050	0.0076	0.743
UlyanovskOblblast	27	2	59	61	2958	0.0091	0.0206	0.74
VolgaFederalDistrict	694	30	1068	1098	104918	0.0066	0.0105	0.771

Figure 2a) shows the influence of the values of the generalized quality indicatorZ_{0i} in a RF subject on the ratio of RTA number to the number of the licensed buses. Figure 2b) - the values of the generalized quality indicatorZ_{0i} in a RF subject on the ratio of RTA number to the number of the licensed buses.

(A)

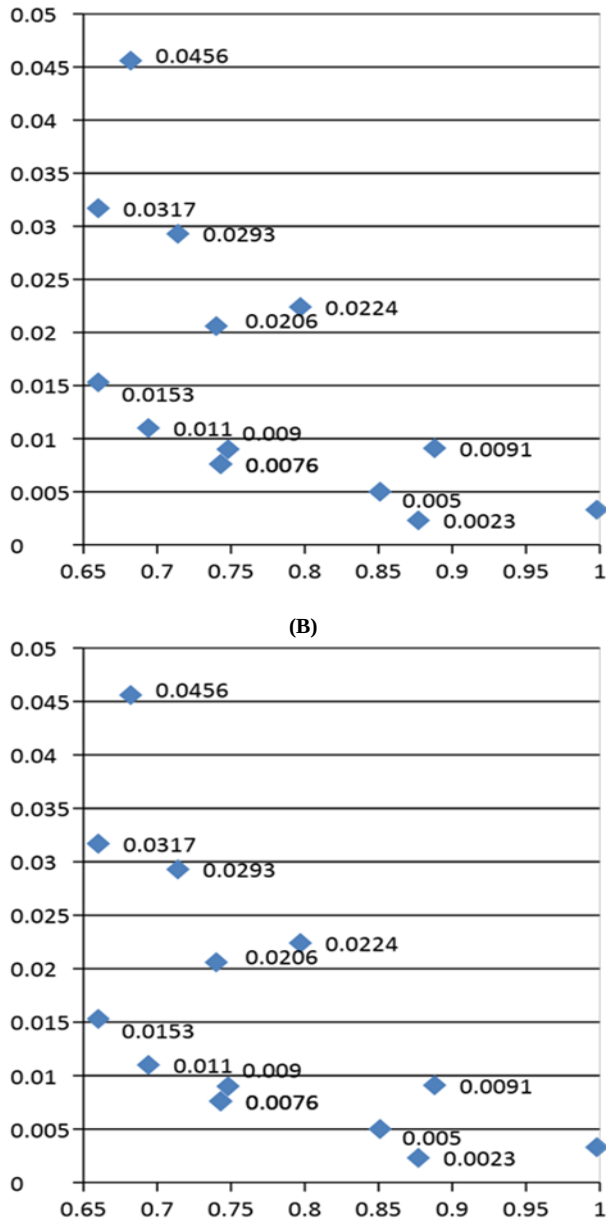

Fig. 2: Dependences: A) Indicator for "Ratio of RTA Number to the Number of the Licensed Buses" on the Values of the Generalized Quality Indicator Z_{0i} in RF Subjects; B) Indicators for "Ratio of the Number of the RTA Injuried to the Number of the Licensed Buses" on the Values of the Generalized Quality Indicatorz_{0i} in RF Subjects.

4. Discussion

The obtained results evidence for the reduction in the values of indicators for "ratio of RTA accidents number to the number of licensed buses" and "ratio of RTA suffered to the number of the licensed buses" with the increase in the summarized value of quality Z_{0i} in the RF subjects.

The correlation coefficient of the indicator for "ratio of RTA number to the number of the licensed buses" and generalized quality indicator Z_{0i} was minus 0.6177. The correlation coefficient of the indicator for "ratio of number of RTA suffered to the number of the licensed buses" and generalized quality indicator Z_{0i} was minus 0.6122. The correlation coefficient values by Chaddock scale evidence the existence of the middle power between the analyzed variables.

The values of the coefficients applied to the motor transport system are quite satisfying to say that the regulation of the technology and organization of the motor transport activity stated in the legislation has a significant impact on the safe transportation of the passengers. It is the simultaneous combination of many factors in system "carrier – passenger – transport vehicle – environment" that makes it difficult to manage the safety of the passengers.

The results of the research provide wide opportunities to manage the safety of the transportation process. The research is based on new theoretical methodological tools proved to be efficient in evaluating the efficiency of the developed motor transport legislation.

With due regard to said above it can be asserted that we have achieved our objective and proved the hypothesis of the research.

5. Conclusion

Thus, it can be affirmed that an important scientific applied task to evaluate the impact of the motor transport legislation on the safety in passenger transportation is solved. The impact should be evaluated by means of new theoretical methodological tools being grounded on the theory of transportation processes and quality management with due regard to the peculiarities of the motor transport and mathematical statistics. The safety of passenger transportation with motor vehicles should be managed by regulating the organizational functional structure of a carrier. The results of the paper can be widely used in developing motor transport legislation, in improving the structure of the requirements, this finally contributing into the improvement of the safety in passenger transportation sphere.

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