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Methodological Foundations for Classification of Suburban Passenger Companies in Russia

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ABSTRACT

To solve the economic tasks of the suburban passenger railway transport, it is necessary to form new and improve the existing methodological foundations of its functioning. At the modern stage of development of passenger transportation in the Russian Federation, as a rule, it is classified per mode of transport and types of transportation. Railway passenger transportation is split per type of transportation services in broad terms into long-distance and suburban transportation services.

The structural reform of railway transport, which had been carried out from 2003 to 2015, resulted in formation of a market of suburban passenger railway transportation. This market is represented by 25 suburban passenger companies, subsidiaries and dependent companies of JSC Russian Railways, by several independent carriers and structural divisions of JSC Russian Railways, performing transportation under special conditions. Suburban passenger railway carriers are subjects of natural monopolies and in most cases are created with participation of regional authorities, and their activities are socially significant for ensuring transport mobility of the population in the regions of the Russian Federation. Thus, the suburban passenger transportation market is a complex system with a special order of interaction of its main actors.

In modern academic literature and in the textbooks, there is a certain gap in classification of structural elements of the passenger transport market. The authors propose to use the ABC–XYZ analysis toolkit to form the so-called «core» of suburban passenger companies and to study regional disproportions in the passenger transport system.

The article proposes a methodological basis for classifying suburban passenger companies depending on the subsidies amount received as per performed passenger turnover. A classification of suburban passenger companies (SPC) was developed based on the study of the ratio of subsidies provided to the suburban passenger entities due to state regulation of tariffs and the performed passenger turnover. The ABC–XYZ analysis of the SPC performance indicators for a considered period allowed to develop their classification and to draw recommendations for assessing the risks of unprofitability and possible ways to reduce them. The identified structure of the suburban passenger transport market can serve as a basis for smoothing out disproportions in the level of public transport services.

Keywords: passenger turnover, transport market, suburban passenger companies, subsidies, financial results, quartile analysis, ABC–XYZ analysis, unprofitability, risk.

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BACKGROUND

The human need for movement is satisfied in the passenger transport market, where transport users and transport organisations providing various transport services interact. The transport market in the field of passenger transportation (the passenger transportation market) has its own distinctive features, like conditions for performing transportation and the need for state regulation, both in Russia and abroad[1,2] [1–4].

Passengers should be considered as transport users, and carrier companies should be considered as market participants. The regulators of the transport market in the field of passenger transportation are federal and regional executive authorities, whose area of responsibility includes formation of tariffs for the services of natural monopolies and antitrust regulation [5; 6].

METHODOLOGY, OBJECTIVES AND PURPOSES OF THE STUDY

The suburban railway transportation market is a complex socio-economic system that was formed as a result of the structural reform of the Russian Federation railway transport in the period from 2001 to 2015. Moreover, the extension of the reform period by five years (to 2010–2015) was largely due to incompleteness of the market transformation of the passenger segment of railway transport both in long-distance and suburban traffic [7–9]. During this period, a system of regulatory and legal acts was formed that regulated the rules and procedure for interaction between market participants in terms of leasing infrastructure, rolling stock and the procedure for compensating income fallen out because of state regulation of tariffs. The federal government provided the necessary financial support to both the infrastructure owner and the subsidised regions; suburban passenger companies (SPCs) were created. However, the existing suburban passenger transportation market cannot be considered homogeneous either in terms of the volumes of transportation performed or in terms of operational, socio-economic and other conditions. In the works of the authors [10; 11], significant unevenness of the allocated subsidies to the suburban passenger companies was revealed both in absolute terms and in relative terms, for example, in terms of the amount of subsidies relative to the completed passenger turnover.

The *objective* of the study is to develop methodological approaches to classifying suburban passenger entities to improve the economic mechanism for its sustainable development.

The research *methodology* is based on the works of domestic and foreign authors in the field of economics of the railway passenger system, as well as on publications of the results of scientific research on its development. The main scientific methods and techniques include methods of the system analysis, mathematical statistics, economic analysis, etc.

The methodological basis for classifying suburban passenger companies in Russia is based on:

– systems analysis, that is, the entire range of methodological tools that are used to develop and substantiate solutions to problems of complex systems;

– the methodology of quartile and ABC–XYZ analysis;

– the methodology of indicative planning and forecasting of performance indicators of transport organisations.

RESULTS

The basic scheme of subsidising the passenger railway companies as a result of state regulation of tariffs is as follows. According to the Methodology for Calculating Economically Justified Costs, suburban passenger companies estimate expected costs by elements and components: for cars, infrastructure and station components of costs in the form of calculating the index of change in operation volumes in vehicle-kilometres, and for locomotive – in train-kilometres. The results of the assessment are submitted to the executive authorities of the region in charge of state regulation of tariffs; based on them, a public order for transportation is than formed [12; 13].

Since due to the state regulation of the tariff it is set below the economically justified level, while fulfilling the public order, lost income is generated, which is subsequently compensated from regional budgets in the form of public assistance to natural monopoly entities.

[1] Concept for development of suburban passenger transportation by rail. Approved by the order of the Government of the Russian Federation dated 19.05.2014 No 857-r. [Electronic resource]: https://docs.cntd.ru/document/499097146?marker=6560IO. Last accessed 18.10.2023.

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The long-distance passenger transportation market also operates a subsidising mechanism to compensate for state regulation of the tariff, for example, for such operators as JSC Federal Passenger Company (JSC FPC) and the Directorate of High-Speed Transportation (DOSS) – a branch of JSC Russian Railways, operating express, speed and high-speed trains[3,4,5]. Regulation of long-distance passenger transportation is carried out according to a different scheme, namely through establishment of a tariff for travel in open-plan sleeping cars and in sitting cars in accordance with the tariff calculated based on the order of the Federal Tariff Service of Russian Federation dated 27.07.2010 No. 156-t/1, adjusted by the integrated index for the relevant period, as well as indexes differentiated by calendar periods of the year [13].

Subsidies are the main source of covering the losses of SPCs, which is confirmed by the fact that structurally, for more than half of the companies, compensations constitute a significant part of revenues[6,7] [2]. The economic justification for the required subsidies' amount is the quarterly reporting on the composition of costs of SPCs [1, 7] [10; 11].

To assess the effectiveness of providing subsidies by regional authorities to SPCs, the authors grouped the amounts of compensations per passenger-kilometre using the calculation of quartiles in a ranked series (see Table 1) having chosen the ratio of the amount of subsidies provided to suburban passenger companies to their passenger turnover as the main analysed indicator based on publicly disclosed corporate reporting. The approximated data set for the period 2021–22 was used exclusively to model the SPCs' classification methodology, and not to compare the performance indicators of individual companies, which was beyond the authors' purposes, and see the relatively short time series. For that reason, further modelling is proposed in the article without mentioning individual companies.

For an in-depth classification of SPCs, the authors conducted a statistical analysis of the efficiency of the subsidies received using the ABC–XYZ method.

ABC-analysis[8,9] [14–15] involves ranking a set of SPCs depending on the ratio of the subsidy to the carrier's passenger turnover. The companies are divided into three groups: Group A – SPC with high budget expenditures per passenger-kilometre; Group B – moderate result of using the subsidy; Group C – the most efficient use of the allocated compensation. The method of distributing SPCs into groups assumes that the following conditions are met: A – SPCs are within first 50 % of the sums of shares as a cumulative total; B – from 50 to 80 % and C – more than 80 % of the cumulative indicator. The results of grouping SPCs using ABC analysis are presented in Table 2.

The next stage of classification is to conduct XYZ-analysis, which ranks the SPCs by the dynamics of indicators, characterising their stability and predictability of change.

The assessment is made based on the calculation of a coefficient of variation for each company for the estimated period of activity. The coefficient of variation is the ratio of the standard deviation to the arithmetic mean, reflecting the degree of scatter of values around the average value.

Thus, the dispersion (σ^2) and the standard deviation σ are calculated using formulas (1) and (2) [9, 11,12]:

[3] On determining the economically justified level of tariffs for transportation of passengers by public rail transport on long-distance routes in open-plan sleeping cars and sitting cars for 2023 and its forecast level for 2024. Order of the Federal Antimonopoly Service of the Russian Federation dated May 5, 2023, No. 270/23. Reference and legal system «Consultant Plus». [Electronic resource]: https://www.consultant.ru/document/cons_doc_LAW_448640/. Last accessed 27.10.2023.

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Table 1

Classification of SPCs by the amount of subsidies per passenger turnover for the period 2021–2022 [11]

Name	Rub./pass.-km for 2021	Name	Rub./pass.-km for 2022
First group – 26,09 %: «Green zone»			
North-West SPC	0,10	North-West SPC	0,15
Kuban Express-Suburb	0,45	Sverdlovskaya PC	0,32
Express-Suburb	0,732	Kuban Express-Suburb	0,38
Sverdlovskaya PC	0,733	Central SPC	0,78
Central SPC	0,89	Express-Suburb	0,92
Altai-suburb	1,09	Altai-suburb	1,26
Second group – 47,82 %: «Central» (Yellow) zone»			
Omsk-suburb	1,10	Samara SPC	1,43
Volgo-Vyatskaya SPC	1,26	Omsk-suburb	1,53
Samara SPC	1,29	Volgo-Vyatskaya SPC	1,54
Commonwealth SPC	1,81	North Caucasian SPC	1,58
Perm PC	2,07	Commonwealth SPC	1,82
North Caucasian SPC	2,25	Perm PC	2,447
Krasprigorod	2,42	Krasprigorod	2,453
Primorye Express	2,48	Primorye Express	2,52
Kuzbass-Suburb	2,49	Kaliningrad SPC	2,77
Kaliningrad SPC	2,68	Volgogradtransprigorod	3,07
Volgogradtransprigorod	3,37	Baikal SPC	3,11
Third group – 26,09 %: «Red zone»			
Baikal SPC	3,47	Kuzbass-Suburb	3,22
SPC Chernozemye	4,20	Bashkortostan SPC	4,82
Bashkortostan SPC	4,95	SPC Chernozemye	5,22
Northern SPC	5,55	Northern SPC	5,91
Transbaikal SPC	11,84	Transbaikal SPC	13,92
PC Sakhalin (suburban traffic)	20,55	PC Sakhalin (suburban traffic)	14,09

Source: compiled by the authors based on the data [6, 7, 10], previous publications [11].

$$\sigma^2 = \frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n}, \quad (1)$$

where $\bar{x}$ is average value of subsidy per passenger turnover for the period under review, rub./passenger-kilometre (pass.-km);

x_i – the value of the su bsidy per passenger turnover for the *i*-th year, rub./pass.-km; *n* is the number of years for which the analysis is conducted,

$$\sigma = \sqrt{\sigma^2}. \quad (2)$$

Therefore, the coefficient of variation (*v*) can be determined by the following formulas [9, 11, 12]:

$$v = \frac{\sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n}}}{\bar{x}} \cdot 100\% \text{ or } v = \frac{\sigma}{\bar{x}} \cdot 100\%. \quad (3)$$

Based on the obtained coefficient of variation, a suburban passenger company is assigned one of three groups: X – if a coefficient of variation is from 0 % to 10 %, which indicates stability and accuracy of forecasting the indicator in question; Y – from 10 % to 25 %, reflecting moderate homogeneity of the population and the probability of deviation of the forecast from the actual situation by no more than 25 %; Z – indicating high variability of the indicator of SPC in question [9, 11, 12]. The results of the grouping are shown in Table 3.

Based on the results of the integration of ABC-analysis and XYZ-analysis, a summarising Table 4 was compiled.

DISCUSSION

The ABC–XYZ analysis showed that structurally the largest share belongs to CX group – 30.43 % (see Table 4). Most of SPCs belonging to CX group are distinguished by fairly high budgetary subsidies. In relation to the volume of transportation operations, these companies consistently show high efficiency of budgetary investments – the average level of subsidy per passenger turnover in the group is

Table 2

ABC analysis of the subsidy structure of SPCs in 2021–2022

PPCs	Subsidies per passenger turnover, rub./pass. -km		Average value, rub./pass.-km	Specific weight, %	Accumulated value, %	Group
	2021 г.	2022 г.				
A	20,55	14,09	17,32	22,64	22,64	A
B	11,84	13,92	12,88	16,83	39,47	A
C	5,55	5,91	5,73	7,49	46,96	A
D	4,95	4,82	4,88	6,38	53,34	B
E	4,20	5,22	4,71	6,15	59,50	B
F	3,47	3,11	3,29	4,30	63,80	B
G	3,37	3,07	3,22	4,21	68,01	B
H	2,49	3,22	2,86	3,73	71,74	B
I	2,68	2,77	2,72	3,56	75,30	B
J	2,48	2,52	2,50	3,26	78,56	B
K	2,42	2,45	2,44	3,18	81,75	C
L	2,07	2,45	2,26	2,95	84,70	C
M	2,25	1,58	1,92	2,51	87,20	C
N	1,81	1,82	1,81	2,37	89,57	C
O	1,26	1,54	1,40	1,83	91,40	C
P	1,29	1,43	1,36	1,78	93,18	C
Q	1,10	1,53	1,31	1,72	94,90	C
R	1,09	1,26	1,18	1,54	96,44	C
S	0,89	0,78	0,84	1,09	97,53	C
T	0,73	0,92	0,82	1,08	98,60	C
U	0,73	0,32	0,53	0,69	99,29	C
V	0,45	0,38	0,42	0,54	99,83	C
W	0,10	0,15	0,13	0,17	100,00	C
Total:	–	–	76,51	100,00	–	–

Source: compiled by the authors based on data [6, 7, 10].

1,47 rub./pass.-km, considering the low variation.

The carriers of CY group are distinguished by a lower degree of stability, however, just like the representatives of CX group, they show that the results of their operations justify the volumes of financial support.

On the contrary, suburban carriers of BX and BY groups are less efficient in terms of the use of compensations and, in comparison with the quartile classification, are completely included in the «central» group. SPCs included in BX have a stable result, however, considering their average efficiency, it is advisable for these carriers to switch to a group with a more dynamic performance indicator.

AX and AY groups require the greatest attention, since the companies referred to them have the highest costs per unit of passenger turnover. Moreover, as ABC–XYZ analysis showed, SPC B and SPC C steadily occupy the positions indicated in the quartile classification (third group).

SPC U (AZ group) showed the highest efficiency of the funds used in 2022. The highest variation indicator is 39,24 % (see Table 4), with its positive trend, indicates the appropriateness of the compensation received and its compliance with the passenger turnover indicators. Forecasting the further activities of SPC U, two main prospects can be noted: strengthening the position, and, consequently, the future transition to CY group or further growth in efficiency while remaining in CZ group.

Comparing the results of the application of subsidies relative to tariff regulation for suburban and long-distance carriers, it is to note that only SPCs included in the lower quartile or groups CY and CZ ABC–XYZ–analysis, namely SPC W and SPC U, correspond to the level of subsidy per passenger turnover applied in 2022 to the regulated segment of JSC Federal Passenger Company (0,26 rub. / pass.-km) [4].

Based on the analysis of the results of SPCs activities in 2021–2022, we can conclude that suburban passenger carriers are strongly dependent on fulfilment of the budget obligations to compensate for losses due to state regulation of tariffs [5; 16–17].

Table 3

XYZ-analysis of the structure of SPCs' subsidising in 2021–2022

PPCs	Average value, rub./ pass.-km	Dispersion	Mean square deviation	Coefficient of variation, %	Group
A	17,32	10,4287	3,2293	18,65	Y
B	12,88	1,0758	1,0372	8,05	X
C	5,73	0,0325	0,1803	3,15	X
D	4,88	0,0046	0,0676	1,39	X
E	4,71	0,2571	0,5071	10,77	Y
F	3,29	0,0318	0,1782	5,41	X
G	3,22	0,0218	0,1475	4,58	X
H	2,86	0,1329	0,3646	12,76	Y
I	2,72	0,0022	0,0473	1,74	X
J	2,50	0,0003	0,0186	0,74	X
K	2,44	0,0003	0,0179	0,74	X
L	2,26	0,0357	0,1890	8,37	X
M	1,92	0,1111	0,3333	17,39	Y
N	1,81	0,0000	0,0069	0,38	X
O	1,40	0,0197	0,1405	10,02	Y
P	1,36	0,0046	0,0678	4,99	X
Q	1,31	0,0449	0,2118	16,12	Y
R	1,18	0,0071	0,0843	7,16	X
S	0,84	0,0031	0,0558	6,68	X
T	0,82	0,0085	0,0920	11,17	Y
U	0,53	0,0426	0,2065	39,24	Z
V	0,42	0,0014	0,0375	9,04	X
W	0,13	0,0008	0,0276	21,86	Y
Total:	3,33	–	–	–	–

Source: compiled by the authors.

Table 4

Classification of SPCs by the subsidies' amount per passenger turnover based on ABC–XYZ analysis for the period 2021–2022

Group name	PPCs	Specific weight, %	Average subsidy amount for the group, rub./pass.-km
AX	B, C	8,70	9,30
BX	D, F, G, I, J	21,74	3,32
CX	K, L, N, P, R, S, V	30,43	1,47
AY	A	4,35	17,32
BY	E, H	8,70	3,78
CY	M, O, Q, T, W	21,74	1,12
AZ	–	–	–
BZ	–	–	–
CZ	U	4,35	0,53
Total:	–	100,00	–

Source: compiled by the authors based on data [6, 7, 10] and Tables 1–3.

CONCLUSION

The results of classification of suburban passenger companies showed, as far as the considered period was concerned, a certain disproportion in the provision of subsidies to the suburban companies, which entail risks of a decrease in the quality of transport services to population and in the efficiency of the regional transport systems.

Quartile and ABC–XYZ-analysis of the operations of the suburban passenger companies for a given period, can if implemented regularly and consistently serve as a basis for making management decisions on the further reforming and developing this sector of transportation in the interests of passengers and the national economy. The classification of SPCs proposed by the authors

and based on ABC–XYZ-analysis informs stakeholders and regulators of the passenger transportation market about the efficiency rate in using the received compensation and the expedience of allocating determined amounts of state support to suburban railway transport. Therewith, the assessment intended for decision-making should be comprehensive and consider the totality of other factors of social, economic and other nature.

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