

**A.B. MANVELIDZE**

Candidate of Economic Sciences, Associate Professor of the Department "Financial Management" of "MSTU "STANKIN".

Areas of scientific interests: economics of air transport

E-mail:

a.b.manvelidze@gmail.com

THE COMPARISON OF PASSENGER TRAFFIC BY AIR AND RAILWAY TRANSPORT

ABSTRACT

The paper studies the distribution of passenger traffic between the domestic air transport serving internal air lines and long-distance railway connection within the Russian Federation. The aim of the paper is to determine the potential for increasing air traffic, especially at ranges up to 2500 km. As initial information we use the statistics of passenger traffic between the pairs of cities in air transport and between destinations in railway transport for 2014 and 2016, the distance between destinations and the current economy class tariffs for flights and tariffs for traveling in compartment carriages for railway transport, as well as information on the availability and conditions of airports at the corresponding destinations.

We have compiled summary tables of transportation for 5000 destinations by both modes of transport. The specific weights of transportation by air transport between the points of departure (departure) and destination (landing) are determined. We conducted the distribution of passenger traffic by range intervals for the Russian Federation as a whole and from major airports: Moscow, Yekaterinburg, Sochi and Simferopol. The quantitative parameters of the tendency towards increase in the share of air transportation with an increase in the distance of transportation were determined. It is shown that 94,2% of rail traffic and 83% of air traffic are carried out at a distance of up to 2500 km. By using the statistics of passenger traffic from Moscow and Ekaterinburg it is shown that the main potential for the growth of air transportation is regional destinations with a length of up to 1000 km. In 2016 the share of air transport in the ranges of up to 1000 km accounted for 16%.

From the analysis of tariffs the conclusions were drawn that air fares exceed railway fares at flight distances up to 1000 km (due to the peculiarities of short flights) and on routes to hard-to-reach areas. The transition of passengers to air transport on regional routes depends on the creation of economic conditions for attracting passengers.

KEY WORDS

PASSENGER TRANSPORT, AIR TRANSPORT, INTERNAL AIR LINES, RAILWAY TRANSPORT, CITY PAIRS, DESTINATIONS, DISTANCE, TARIFF, DISTRIBUTION; SHARE OF AIR TRANSPORT, REGIONAL TRANSPORTATION; GROWTH POTENTIAL.

INTRODUCTION

From 1991 to 2000 air transportation of domestic air lines decreased from 84,6 million passengers to 13,4 million passengers, or more than 6 times. Since 2001 the transportation was increasing annually with the exception of the crisis year 2009. By 2016 the transportation by domestic air lines increased to 56,4 million passengers, which was 66,6% of the 1991 level.

The transportation from major cities to Moscow, St. Petersburg, Sochi, Yekaterinburg, Kaliningrad and Simferopol was restored at high rates. A significant contribution to the growth of air traffic (more than 2 million annually) was made by shift transportation.

The lowest rates of restoration of regional destinations are observed in the Central, North-Western, Ural, Southern and North-Caucasian federal districts.

The growth of traffic in the Volga Federal District was somewhat accelerated after the introduction of targeted subsidies for regional flights.

At the same time, the main potential for the growth of air transportation is concentrated in these densely populated federal districts with more than 80% of the population, the concentration of production, financial, scientific and recreational resources of the country. It should be noted that air transport is not represented in internal tourism, for example, on the routes of the "Golden Ring" and the "Silver Ring".

To develop the concept of development of regional aviation in the Russian Federation, it is important to have data on the general mobility of the population and on the competition of modes of transportation according to destinations. For this purpose the study compares the volumes of passenger traffic by competing modes of transport – by air (domestic air lines) and rail (long-distance traffic) within Russia.

Fig. 1. The trend of changes in the share of air transportation according to the intervals in the distance of transportation



For this study we used the statistics of passenger traffic between city pairs in air transport and between

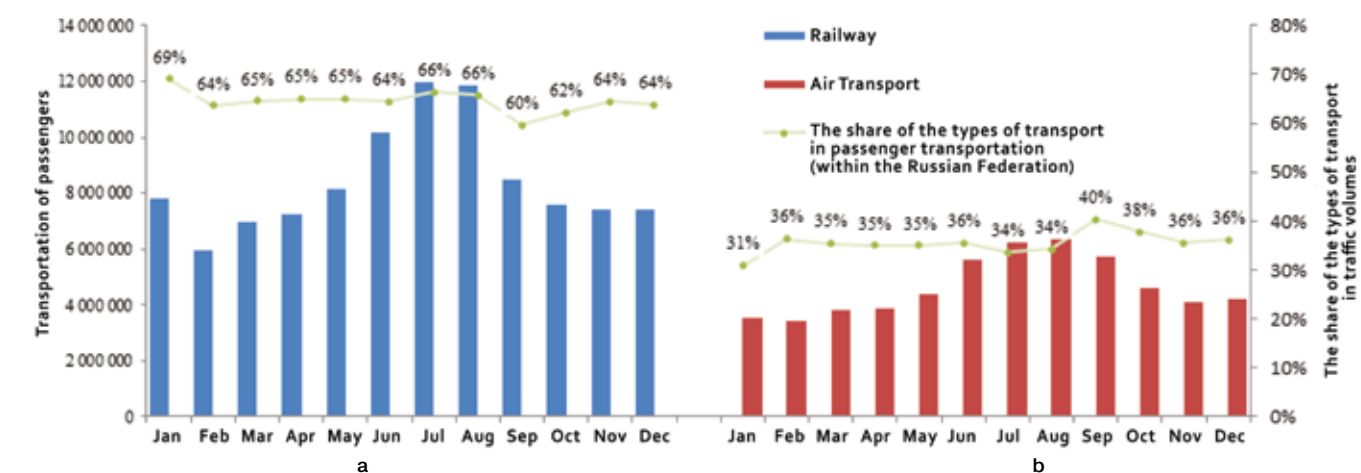
По данным за 2014 и 2016 годы, распределений в destinations in railway transport for 2014 and 2016 determining the distances between destinations and analyzing the current tariffs. We also conducted the distribution of passenger transportation for the entire array of available information determining the ratios of transportation by competing modes for the routes with different distances as well as the trends of changes in tariffs according to the modes and ranges of transportation.

The aim of the study is to identify the potential for increasing air transport by destinations.

In 2016 56,4 million passengers were transported by air and 102,6 million passengers by railway. Compared to 2014, air transportation increased by 22%, and railway transportation – by 6%. In the total volume of passenger transportation by these two types of transport – aviation and railway, in the long-distance transportation the share of air transport was 35%, that is 3% higher than in 2014.

According to the data for 2014 and 2016, the distribution of passenger traffic by air and railway in terms of distances in Russia in general and individual cities (Moscow, Ekaterinburg, Sochi and Simferopol) is presented in Table. 1. Regarding the

Fig. 2. The comparison of the volumes of passenger transportation by railway (a) and air (b) transport by months in 2016



the comparison of passenger traffic by air and railway transport

RESEARCH RESULTS BY LARGE TRANSPORT NODES

Moscow

In 2016 41,1 million passengers were transported by air from Moscow. Compared to 2014, in 2016 air traffic from Moscow increased by 19 %. 46.4 million passengers were transported by rail, or 17% more than in 2014. In the overall transportation of two modes of transport the share of air transportation increased from 46% in 2014 to 47% in 2016.

Air and railway destinations from Moscow were analyzed: 194 in 2016 and 192 in 2014. The transportation by two modes

transportation by air and railway transport, there is a trend towards changing in the share of air transport by the distance of transportation in Russia (Figure 1).

The main potential for increasing air transportation is regional transportation for distances up to 1000 km. To determine the specific directions of transportation, the transportation from Moscow, Yekaterinburg and Sochi was analyzed. For this purpose similar groups of traffic directions are identified. The comparison of passenger tariffs of aviation and railway transport for the same destinations was also made. Within a year the ratio between the transportation by two modes of transport varies: air transportation is to a lesser degree subject to seasonal fluctuations, and in the summer months their share of traffic decreases (Figure 2).

Table 2
Transportation on the largest routes of air travel to Moscow (round trip) in 2014-2016, thousand people.

Aiport of departure	Airport of destination	Distance interval, km.	2016		2014		The share of air transportation, %	
			Railway transport	Air transport	Railway transport	Air transport	2016	2014
Moscow	Voronezh	up to 500	1098	332	1054	254	23	19
Moscow	cheboksary	501–1000	634	147	663	39	19	5
Moscow	Belgorod	501–1000	916	251	742	163	21	18
Moscow	St. Petersburg	501–1000	8930	3817	6848	3378	30	33
Moscow	Kazan	501–1000	1162	992	1180	762	46	39
Moscow	Kirov	501–1000	578	122	653	42	17	6
Moscow	Samara	501–1000	800	1193	880	962	60	52
Moscow	Volgograd	501–1000	405	692	427	489	63	53
Moscow	Rostov-on-Don	501–1000	439	1375	514	1167	76	69
Moscow	Ufa	1001–1500	166	1103	197	940	87	83
Moscow	Perm	1001–1500	287	779	331	668	73	67
Moscow	Kaliningrad	1001–1500	246	1115	226	854	82	79
Moscow	Krasnodar	1001–1500	257	1934	271	1830	88	87
Moscow	Anapa + Novorossiysk	1001–1500	986	953	896	649	51	41
Moscow	Simferopol	1001–1500	1	3381	53	1933	100	97
Moscow	Astrakhan	1001–1500	122	446	169	316	79	65
Moscow	Mineralnye Vody	1001–1500	387	1292	375	1225	77	77
Moscow	Sochi	1001–1500	731	3433	682	1958	82	74
Moscow	Ekaterinburg	1001–1500	247	1697	293	1468	87	83
Moscow	Nalchik	1501–2000	–	161	–	67	100	100
Moscow	Vladikavkaz	1501–2000	166	355	219	179	68	45
Moscow	Nazran	1501–2000	0	192	0	84	100	100
Moscow	Chelyabinsk	1501–2000	97	889	102	796	90	89
Moscow	Murmansk	1501–2000	323	441	400	314	58	44
Moscow	Makhachkala	1501–2000	125	728	204	360	85	64
Moscow	Tyumen	1501–2000	185	714	252	509	79	67
Moscow	Surgut	2001–2500	–	560	–	436	100	100
Moscow	Sabetta	4001–4500	–	139	–	–	100	–
Moscow	Voronezh	up to 500	1098	332	1054	254	23	19
Total			19288	29234	17631	21841	60	55

Table 1
Distribution of passenger transportation by distance

Interval of transport distances, km.	Total in the domestic (long-distance) routes in Russia																Total
	— 500	501 1000	1001 1500	1501 2000	2001 2500	2501 3000	3001 3500	3501 4000	4001 4500	4501 5000	5001 5500	5501 6000	6001 6500	6501 7000	7001 7500	7501 8000	
Air passengers in 2016, thousand	1890	12673	20046	7329	4877	1634	2053	1512	1214	209	615	178	219	1200	659	15	56324
Air passengers in 2014, thousand	1671	10645	15337	5404	3971	1534	1891	1262	954	228	661	213	200	1385	652	5	46016
Passengers of railway transport in 2016, thousand	44713	34455	12051	5916	2546	1383	640	324	231	123	160	61	14	19	—	—	102636
Passengers of railway transport in 2014, thousand	45811	29952	11086	5387	1992	1168	556	293	168	96	195	53	60	17	33	—	96867
The share of air transport in passenger traffic in 2016, %	4	27	62	55	66	54	76	82	84	63	79	75	94	98	100	100	35
The share of air transport in passenger traffic in 2014, %	4	26	58	50	67	57	77	81	85	70	77	80	77	99	95	100	32
Moscow																	
Air passengers in 2016, thousand	957	9578	17873	3932	2321	1113	1279	858	881	151	489	168	171	1194	645	—	41609
Air passengers in 2014, thousand	827	7902	13501	2821	2343	1158	1283	896	716	199	561	207	176	1365	607	—	34563
Passengers of railway transport in 2016, thousand	18159	20635	5224	1809	128	69	160	75	50	24	58	5	6	18	—	—	46420
Passengers of railway transport in 2014, thousand	13280	18721	5345	1949	99	63	154	43	39	31	52	5	4	17	29	—	39830
The share of air transport in passenger traffic in 2016, %	5	32	77	68	95	94	89	92	95	86	89	97	97	99	100	—	47
The share of air transport in passenger traffic in 2014, %	6	30	72	59	96	95	89	95	95	87	92	98	98	99	95	—	46
Simferopol																	
Air passengers in 2016, thousand	48	190	3487	722	357	82	88	149	17	31	9	—	11	—	—	9	5198
Air passengers in 2014, thousand	47	118	1962	373	84	18	15	25	2	5	2	—	3	—	—	3	2658
Passengers of railway transport in 2016, thousand	70	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	72
Passengers of railway transport in 2014, thousand	88	0	53	4	—	—	—	—	—	—	—	—	—	—	—	—	145
Sochi																	
Air passengers in 2016, thousand	76	62	3546	284	755	100	51	140	45	—	3	—	20	0	—	—	5082
Air passengers in 2014, thousand	95	1	1998	78	421	56	23	47	28	5	1	—	10	—	—	—	2763
Passengers of railway transport in 2016, thousand	3088	599	1567	772	626	202	26	71	24	6	9	—	—	1	—	—	6990
Passengers of railway transport in 2014, thousand	2671	544	1414	654	435	149	23	60	14	5	6	—	—	0	—	—	5976
The share of air transport in passenger traffic in 2016, %	2	9	69	27	55	33	66	66	66	—	27	—	100	4	—	—	42
The share of air transport in passenger traffic in 2014, %	3	0	59	11	49	27	50	44	66	49	9	—	100	—	—	—	32
Ekaterinburg																	
Air passengers in 2016, thousand	29	92	1905	360	583	—	13	16	6	18	36	0	4	—	—	—	3062
Air passengers in 2014, thousand	54	92	1620	252	264	—	18	5	7	4	28	—	1	—	—	—	2344
Passengers of railway transport in 2016, thousand	2525	704	577	357	201	179	26	14	4	—	16	—	—	—	—	—	4603
Passengers of railway transport in 2014, thousand	2940	699	646	404	156	131	23	17	3	—	11	—	48	—	—	—	5078
The share of air transport in passenger traffic in 2016, %	1	12	77	50	74	—	34	54	60	100	69	100	100	—	—	—	40
The share of air transport in passenger traffic in 2014, %	2	12	71	38	63	—	45	22	70	100	72	—	3	—	—	—	32

of transport was carried out in 72 directions in 2016 and 69 in 2014.

Air transportation was not carried out in 56 directions in 2016 and 64 in 2014 while one half of them are directions with a length of less than 1000 km from large railway junctions: Ryazan, Ruzaevka, Orel, Bologoye, Vyazma, Murom, Unecha and others. The railway passenger transportation was not carried out to Surgut, Novy Urengoy, Nizhnevartovsk, Yuzhno-Sakhalinsk, Petropavlovsk-Kamchatsky, Nizhnekamsk, Yakutsk, Norilsk and other remote cities in 66 directions in 2016 and 59 in 2014.

More than 70% of all air traffic by Russian companies is carried out on domestic air routes and 45% of passenger transportation by railway on long-distance routes from Moscow.

In terms of traffic volumes and the share of air transport in transportation from Moscow we have identified the following groups:

- *The first group* consists of 28 routes, on which the air transportation of passengers accounted for at least 20% of the total volume of transportation by the two modes of transport in 2014 and 2016. 28 directions of air transportation account for 70% of air traffic from Moscow (about 30 million air passengers). Compared to 2014 the growth of passenger traffic in 2016 was 9% for the railway transport and 34% for the air transport (see Table 2).
- *The second group* consists of 10 routes to Siberia and the Far East. In long-distance destinations the air transport carried 4,64 million passengers in 2014 and 4,17 million passengers in 2016. In 10 months of 2017 there was an increase in air transportation on long-distance destinations. The share of air transport in long-distance routes from Moscow is 95% (Table 3).

- *The third group* consists of 12 routes, on which the main volume of transportation (more than 76% in 2016) is carried out by railway transport (Table 4). A total of 15,5 million passengers in 2014 and 18,2 million passengers in 2016 were transported on the routes of the third group. 100% of traffic is carried out at a range of up to 1000 km. The volumes of this transport of passengers can be considered as a significant potential for the development of regional air transport connection from Moscow. According to the calculation, with an increase in the share of air transportation from Moscow (see Table 4) to one third (to Kazan up to 50% and to Samara up to 70%) it will be possible to transport 3,5 million more passengers – an increase of 95% (Table 5).

The comparative data on tariffs of air and railway transport are shown in Fig. 3. For the railway transport tariffs for compartments are considered.

Aviation tariffs are 2 times higher than the average trend on those routes where there is no railway connection.

Aviation tariffs are also higher on those routes where the range of flight is less than 1000 km, which is caused by high fees of airports and air navigation services needed for non-stop flights. On the remaining routes tariff rates for the air and railway transport are in the same price range.

Ekaterinburg

In 2016 3,062 million passengers were transported from Ekaterinburg (+ 31% compared with 2014) by air transport and 4,603 million (– 9% compared with 2014) by railway long-distance transport. In the general transportation of passengers the share of air transport increased from 32% in 2014 to 35% in 2016.

In terms of traffic volumes and the share of air transport in transportation from Ekaterinburg we have identified the following groups:

- *The first group* consists of 20 routes, on which the air transportation of passengers accounted for at least 20% of the total volume of transportation by the two modes of transport in 2014 and 2016. The main routes of air transportation account for more than 90% of air traffic from Ekaterinburg (Table 6). Compared with 2014 the growth of air transportation in 2016 was 35%.
- *The second group* consists of 36 routes on which only air transportation is carried out, in 2016 there was no railway connection. In 2016 the total volume of transportation on such "hard to reach" destinations was about 200 thousand passengers, or 7% of the total air transportation from Ekaterinburg (Table 7).
- *The third group* consists of 40 routes, on which the main volume of traffic (more than 76% in 2016) is carried

Table 3

Air transportation to Moscow (round trip) on distant routes, thousand people

Point of destination	Interval of distances, km	Absolute number		Share, %		Dynamics of 10 months		
		2014	2016	2014	2016	2014	2016	2017
Omsk	2001–2500	618	541	88	82	173	143	163
Novosibirsk	2501–3000	1158	1113	95	94	570	486	523
Kemerovo	3001–3500	214	174	91	89	182	146	202
Krasnoyarsk	3501–4000	743	712	95	94	634	591	726
Ulan-Ude	4501–5000	197	151	91	93	967	939	954
Chita	5001–5500	210	171	94	91	521	457	483
Blagoveshchensk	5501–6000	207	168	100	100	172	133	139
Khabarovsk	6501–7000	624	567	98	98	537	491	525
Vladivostok	6501–7000	669	575	99	99	181	151	156
Total		4640	4172	95	93	3937	3537	3871

Table 4

Directions of passenger transportation to Moscow (round trip) with railway transport, thousand people

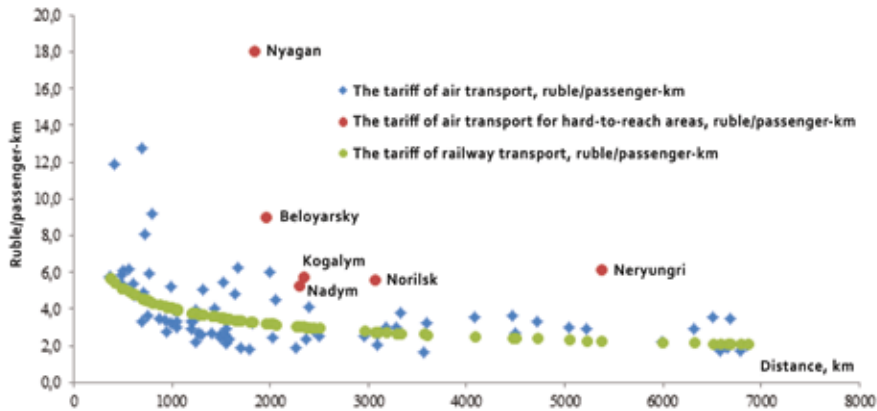
Point of destination	Interval, km	2016		2014		The share of air transportation, %	
		Railway transport	Air transport	Railway transport	Air transport	2016	2014
Belgorod	501–1000	916	251	742	163	21	18
Bryansk	up to 500	1295	0,1	1055	0,3	0,005	0,033
Vladimir	up to 500	956	0,0	425	0,004	0,0	0,0
Voronezh	501–1000	1098	332	1054	254	23	19
Kazan	501–1000	1162	992	1180	762	46	39
Kursk	501–1000	843	23	832	22	3	3
Nizhniy Novgorod	up to 500	2203	464	2088	443	17	18
Penza + Ruzayevka	501–1000	1605	71	1673	51	4	3
Ryazan	up to 500	1248	–	254	0,0	0	0
Samara	501–1000	800	1193	880	962	60	52
Saratov	501–1000	1108	341	1099	341	24	24
Yaroslavl	up to 500	1351	0,4	1244	1	0,03	0,10
Total	–	14584	3667	12524	3000	20	19

Table 5

The calculation of the growth of air transportation with an increase in the share of air transport, thousand people.

Point of destination	Assumption		Growth of air transport	Tariffs for air transportation	Tariffs for railway transportation			
	Share, %	Air transport			seat	economy	compartment	Speed trains
Belgorod	33	389	138	From 2400 to 3200	1007	1438	3515	—
Bryansk	33	432	432	From 1000 to 2000	856	1000	2204	—
Vladimir	33	319	319	From 1000 to 1500	1267	2450	4711	1127
Voronezh	33	477	145	From 2400 to 2800	—	873	2979	1272
Kazan	50	1077	85	From 1300 to 2300	—	960	2387	—
Kursk	33	289	265	From 2500 to 3100	1355	1128	2303	1192
Nizhniy Novgorod	33	889	425	From 1700 to 1900	—	1715	3012	1211
Penza + Ruzayevka	33	559	488	From 2800 to 3050	990	960	2396	—
Ryazan	33	416	416	From 1000 to 1500	—	579	2062	—
Samara	70	1395	202	From 1900 to 2300	—	1293	3295	1211
Saratov	33	483	142	From 4100 to 5200	1063	1048	2637	—
Yaroslavl	33	450	450	From 7500 to 7500	580	1565	—	—
Total	39	7174	3507					

Fig. 3. Tariff rates on the routes to Moscow and from Moscow. The comparison of air and railway fares (a travel in compartment)



out by railway transport. On these routes 3,5 million passengers in 2014 and 3,2 million passengers in 2016 were transported. 80% of traffic is carried out at a range of up to 1000 km. (Table 8). The volumes of transportation of the third group can be considered as a potential for the development of regional air transport connection with the possibility of implementation depending on the readiness of the airport network to serve regional flights.

The comparative data on tariffs of air and railway transport from Ekaterinburg are shown in Fig. 4 showing the fares of above average level to hard-to-reach airports as well as the closest airports: Chelyabinsk, Magnitogorsk and Ulyanovsk.

Sochi

In 2016 5,082 million passengers were transported to and from Sochi by air (the growth of 1,8 times compared to 2014) and by railway – about 7 million passengers (the growth of 17%). The share of air transportation in the general passenger traffic increased from 32% in 2014 to 42% in 2016. The transportation of passengers on the route Moscow – Sochi and in the opposite direction makes up 67,5% of the total volume of

air transportation. The growth of air transportation to Sochi after 2014 is explained by the closure of charter flights to Egypt and Turkey. In total, air transportation to and from Sochi was carried out in 70 directions.

For 8 directions in 10 months of 2017 the growth of traffic to Sochi was on average 4% compared to the same period in 2016 including the route Moscow – Sochi with an increase in air transportation by 1%.

Fig. 4. Tariff rates on the routes to Ekaterinburg and from Ekaterinburg. The comparison of air and railway tariffs (in compartment cars)

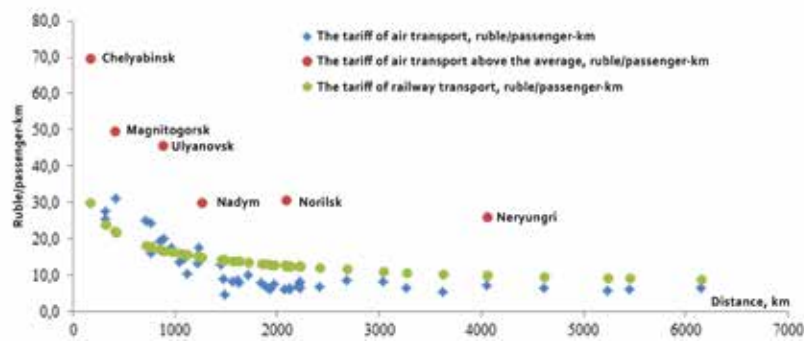


Table 6

The share of air transportation on the largest air traffic routes from Ekaterinburg (round trip) in 2014-2016, thousand people.

Airport of departure	Airport of destination	Interval of distance, km	2016		2014		The share of air transportation, %	
			Railway transport	Air transport	Railway transport	Air transport	2016	2014
Ekaterinburg	Ufa	Up to 500	48	16	67	16	25	19
Ekaterinburg	Moscow	1001–1500	247	1697	293	1468	87	83
Ekaterinburg	Novosibirsk	1001–1500	81	109	89	49	57	36
Ekaterinburg	Samara	1001–1500	49	37	58	18	43	24
Ekaterinburg	Nizhny Novgorod	1001–1500	42	5	47	16	11	25
Ekaterinburg	Volgograd	1501–2000	26	7	27	0	21	1
Ekaterinburg	St. Petersburg	1501–2000	135	291	158	203	68	56
Ekaterinburg	Mineralnye Vody	1501–2000	25	20	27	33	45	55
Ekaterinburg	Tomsk	1501–2000	15	6	18	1	30	4
Ekaterinburg	Voronezh	1501–2000	11	6	15	—	37	—
Ekaterinburg	Rostov-on-Don	1501–2000	20	18	28	13	47	31
Ekaterinburg	Simferopol	2001–2500	—	172	0,6	43	100	99
Ekaterinburg	Sochi	2001–2500	110	251	72	89	70	55
Ekaterinburg	Anapa + Novorossiysk	2001–2500	153	71	119	35	32	23
Ekaterinburg	Krasnodar	2001–2500	36	33	29	48	48	62
Ekaterinburg	Krasnoyarsk	2001–2500	30	27	31	21	47	40
Ekaterinburg	Irkutsk	3001–3500	19	10	17	13	34	44
Ekaterinburg	Chita	3501–4000	10	16	13	5	62	27
Ekaterinburg	Vladivostok	5001–5500	4	19	3	13	83	83
Ekaterinburg	Khabarovsk	5001–5500	8	17	5	15	69	75
Total	—		1069	2827	1117	2097	73	65

Table 7

Air transportation from Ekaterinburg (round trip) on different routes, passengers.

Airport of departure	Airport of destination	Interval of distance, km	Air transport		The share of air transportation, %	
			2016	2014	2016	2014
Ekaterinburg	Beloretsk	Up to 500	—	—	100	—
Ekaterinburg	Sovyetskiy	Up to 500	5297	6979	100	100
Ekaterinburg	Urai	Up to 500	3414	6630	100	100
Ekaterinburg	Beloyarsky	501–1000	9126	9815	100	100
Ekaterinburg	Nizhnekamsk	501–1000	983	2080	100	100
Ekaterinburg	Surgut	501–1000	31548	31328	100	100
Ekaterinburg	Syktvykar	501–1000	10135	5231	100	100
Ekaterinburg	Khanty-Mansiysk	501–1000	10011	15877	100	100
Ekaterinburg	Varandey	1001–1500	11	—	100	—
Ekaterinburg	Nadym	1001–1500	9754	11182	100	100
Ekaterinburg	Nizhnevartovsk	1001–1500	8842	7511	100	100
Ekaterinburg	Novy Urengoy	1001–1500	15399	7191	100	100
Ekaterinburg	Noyabrsk	1001–1500	8913	8218	100	100
Ekaterinburg	Salekhard	1001–1500	13409	16231	100	100
Ekaterinburg	Saransk	1001–1500	64	112	100	100
Ekaterinburg	Usinsk	1001–1500	7	—	100	—
Ekaterinburg	Cherepovets	1001–1500	209	243	100	100
Ekaterinburg	Belgorod	1501–2000	6264	62	100	100
Ekaterinburg	Gorno-Altaysk	1501–2000	668	—	100	—
Ekaterinburg	Kogalym	1501–2000	6	441	100	100
Ekaterinburg	Kursk	1501–2000	99	132	100	100
Ekaterinburg	Petrozavodsk	1501–2000	3	63	100	100
Ekaterinburg	Ramenskoye	1501–2000	45	—	100	—
Ekaterinburg	Yamburg	1501–2000	1637	1092	100	100
Ekaterinburg	Gelendzhik	2001–2500	16737	14031	100	100
Ekaterinburg	Murmansk	2001–2500	79	—	100	—
Ekaterinburg	Norilsk	2001–2500	12625	14155	100	100
Ekaterinburg	Sabetta	2001–2500	7	—	100	—
Ekaterinburg	Bratsk	2501–3000	22	—	100	—
Ekaterinburg	Dikson	2501–3000	20	—	100	—
Ekaterinburg	Mirny	3001–3500	3165	3860	100	100
Ekaterinburg	Neryungri	4001–4500	7	1858	100	100
Ekaterinburg	Yakutsk	4001–4500	5748	5048	100	100
Ekaterinburg	Blagoveshchensk	4501–5000	18458	3748	100	100
Ekaterinburg	Yuzhno-Sakhalinsk	5501–6000	296	—	100	—
Ekaterinburg	P.-Kamchatsky	6001–6500	3845	1283	100	3
Total	—	—	197051	174401	100	79

Table 8
with the advantages of railway transport, thousand passengers

Point of destination	Interval of distance, km	2016		2014		The share of air transportation, %	
		Railway transport	Air transport	Railway transport	Air transport	2016	2014
Tymen	Up to 500	853	4,9	1040	11,6	0,57	1,10
Serov	Up to 500	392	—	408	—	—	—
Perm	Up to 500	365	2,4	461	0,6	0,64	0,12
Izhevsk	Up to 500	203	0,9	209	7,6	0,43	3,52
Kurgan	Up to 500	193	0,0	217	4,3	0,02	1,95
Tavda	Up to 500	144	—	148			
Magnitogorsk	Up to 500	21	0,7	19	6,8	3,09	26,79
Chusovskaya	Up to 500	15	—	23	—	—	—
Zlatoust	Up to 500	9	—	11	—	—	—
Kazan	501–1000	195	12,1	153	1,3	5,81	0,84
Omsk	501–1000	137	7,2	134	2,5	4,97	1,85
Orenburg	501–1000	86	5,4	96	7,0	5,88	6,83
Kirov	501–1000	85	0,0	94	0,1	0,01	0,09
Orsk	501–1000	84	0,1	102	0,3	0,08	0,33
Solikamsk	501–1000	37	—	40	—	—	—
Zuyevka	501–1000	31	—	32	—	—	—
Ulyanovsk	501–1000	23	0,1	20	4,7	0,27	19,00
Sharya	501–1000	9	—	10	—	—	—
Alatyr	501–1000	6	—	6	—	—	—
Saratov	1001–1500	33	1	32	18	1,68	35,77
Cheboksary	1001–1500	25	—	28	—	—	—
Vologda	1001–1500	19	0,0	17	—	0,24	—
Penza	1001–1500	25	—	25	—	—	—
Sizran	1001–1500	9	—	9	—	—	—
Kostroma	1001–1500	8	—	9	0,2	—	2,61
Yoshkar-Ola	1001–1500	6	—	6			
Barnaul	1501–2000	30	—	33	0,4	—	1,32
Novokuznetsk	1501–2000	15	0,1	16	0,1	0,40	0,88
Kemerovo	1501–2000	15	0,2	17	0,7	1,22	3,85
Makhachkala	1501–2000	14	0,1	13	0,1	0,94	0,96
Vladimir	1501–2000	11	—	12	—	—	—
Starominskaya	1501–2000	11	—	2	—	—	—
Arzamas	1501–2000	8	—	8	—	—	—
Sary Oskol	1501–2000		—	4	—	—	—
Armavir	2001–2500	9	—	10	—	—	—
Astrakhan	2001–2500	5	—	5	0,0	—	0,22
Nizhneudinsk	2001–2500	5	—	4	—	—	—
Abakan	2501–3000	15	—	2	—	—	—
Lena	2501–3000	11	—	10	—	—	—
Ulan-Ude	3001–3500	6	0,003	6	1,5	0,05	19,93
Tynda	3501–4000	2	—	2	—	—	—
Ussuriysk	5001–5500	5	—	3	—	—	—
Total	—	3175	35	3495	68	1,1	1,9

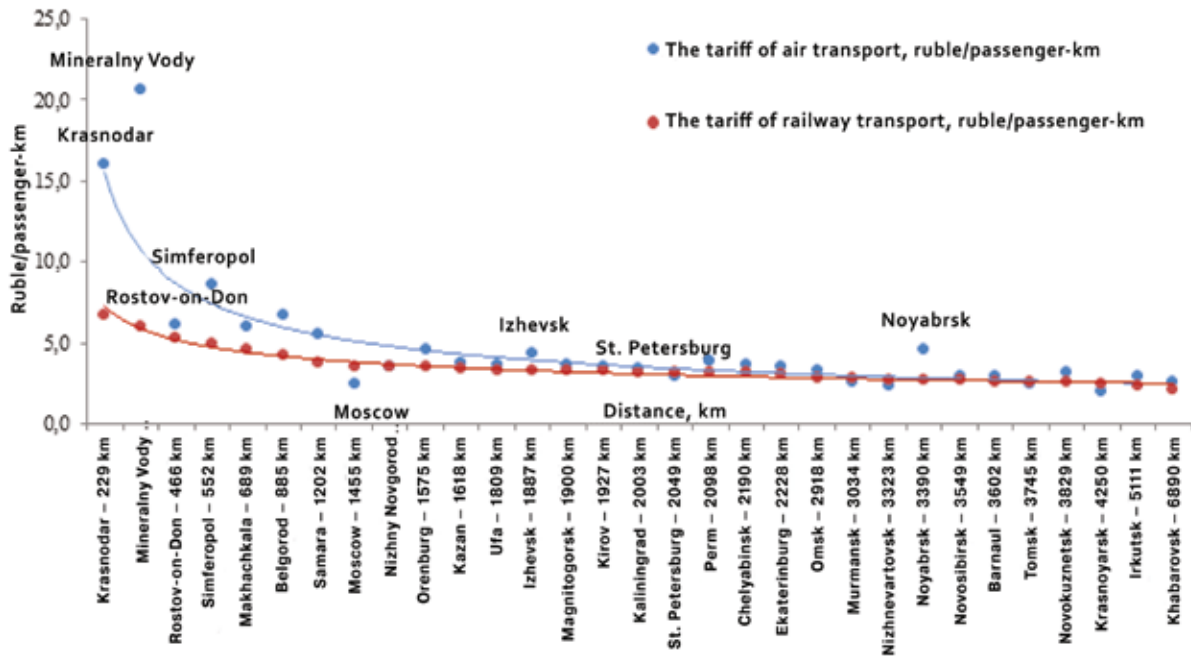
Table 9
Air transportation from Ekaterinburg (round trip) on the main routes, passengers

Point of destination	Interval of distance, km	Air transport			Share in total passenger traffic		Air transportation in 10 months of 2017			Growth	
		2014	2016	growth: 2016 to 2014	2014	2016	2014	2016	2017	2016 to 2014	2017 to 2016
Krasnodar	До 500	92,1	62,1	68	5	8	75	48	63	64	130
Samara	1001–1500	24,9	78,6	316	33	17	25	76	74	309	98
Moscow	1001–1500	1957,6	3433,4	175	82	74	1732	3087	3121	178	101
Kazan	1501–2000	28,5	87,2	306	48	28	641	86	79	13	92
Ufa	1501–2000	19,2	78,3	407	51	26	19	78	66	417	85
St. Petersburg	2001–2500	283,8	407,1	143	62	63	258	363	467	141	128
Ekaterinburg	2001–2500	88,5	251,3	284	70	55	83	236	245	286	104
Novosibirsk	3501–4000	32,3	129,9	402	78	51	30	125	151	418	121
Total		2527	4528	179	62	53	2862	4099	4266	143	104

Table 10
Railway transportation to and from Sochi on the main routes in 2016

Point of destination	Passengers, thousand	Point of destination	Passengers, thousand
Krasnodar	1263,9	Samara	158,8
Moscow	730,9	Vladikavkaz	110,9
Rostov-on-Don	669,4	Ekaterinburg	110,2
Armavir	442,9	Nizhny Novgorod	100,5
Mineralny Vody	306,9	Kazan	95,0
Voronezh	274,7	Perm	87,4
St. Petersburg	249,7	Chelyabinsk	77,0
Volgograd	238,1	Ufa	75,7
Saratov	174,5	Total	5166,4

Fig. 5. Tariff rates on the routes to Sochi and from Sochi:
a – air tariffs; b – railway tariffs (in compartment cars)



In 2016 passenger transportation from Moscow to Sochi by railway amounted to 10% of the total sum of transportation to Sochi by railway transport in all directions. Other largest destinations for railway passenger transportation from Sochi are shown in Table. 10. More than 70% of passenger railway transportation to and from Sochi was carried out on the major routes.

The growth of the passenger air transportation to and from Sochi can be ensured by increasing the number of flights on those routes where there is considerable railway transportation and where air transport is in many ways inferior to it or not used. The list of potentially possible routes of air transportation from Sochi is given in Table. 11. The average range of transportation is up to 1000 km.

CONCLUSIONS

In 2016, 159 million passengers were transported by air and railway transport on the territory of the Russian Federation, including 35% by air transport (for comparison: in 2014 – 32%).

The share of air transportation grows with an increase in the range of passenger traffic (Table 13).

At distances of up to 2500 km more than 90% of passenger transportation is carried out by two modes of transport: 97% by railway from the total volume of railway transportation and 83% by air from the total volume of air transportation.

At distances of up to 1000 km 60% of passenger transportation is carried out by two modes of transport: 77% by railway from the total volume of railway transportation and 26% by air transport from the total volume of air transportation.

Table 11
Potential directions for increasing air transportation from/to Sochi to the indicated destinations, thousand passengers

Point of destination	Interval of distance, km	2016		2014		The share of air transportation, %	
		Railway transport	Air transport	Railway transport	Air transport	2016	2014
Krasnodar	Up to 500	1263878	62220	1004818	92131	5	8
Stavropol	Up to 500	20467	375	27449	—	2	
Mineralny Vody	Up to 500	306927	4435	353854	2155	1	1
Starominskaya (Yeysk)	Up to 500	47301	—	26107	—	—	—
Salsk	Up to 500	45507	—	54656	—	—	—
Armavir	Up to 500	442883	—	308983	—	—	—
Vladikavkaz	Up to 500	110879	165	123858	—	0,1	—
Rostov-on-Don	Up to 500	669447	6028	692730	605	1	0,1
Millerovo	Up to 500	33164	—	33979	—	—	—
Volgograd	501–1000	238129	18427	228117	—	7	—
Voronezh	501–1000	274674	9725	229472	177	3	0
Kursk	1001–1500	50477	1164	36946	1465	2	4
Michurinsk	1001–1500	23950		23360	—	—	—
Ruzaevka (Saransk)	1001–1500	26018	—	28812	—	—	—
Saratov	1001–1500	174460	6239	161642	6187	3	4
Bryansk	1001–1500	50190	4402	50104	76	8	0,2
Tambov	1001–1500	21666	—	18144	1569	—	8
Tula	1001–1500	32183	—	28409	—	—	—
Orel	1001–1500	21296	—	18299	—	—	—
Ulyanovsk	1001–1500	74606	3142	55363	—	4	—
Ryazan	1501–2000	54502	—	57589	—	—	—
Yaroslavl	1501–2000	62461	5745	53352	157	8	0,3
Syzran	1501–2000	40849	—	33640	—	—	—
Vladimir	1501–2000	22176	—	20353	—	—	—
Smolensk	1501–2000	29691	—	22270	—	—	—
Izhevsk	1501–2000	74810	6515	56913	6120	8	10
Vologda	2001–2500	60547	—	47079	9	—	0,02
Orsk	2501–3000	27606	—	22004	—	—	—
Total	—	4300744	128582	3818302	110651	2,9	2,8

Table 12
The problems of airports, which restrict the use of the Russian jet aircraft SSJ-100

Railway station	Problem description
Starominskaya	Located in 65 km from the Yeysk airport, which belongs to the Ministry of Defense. It is planned to create a civil air traffic on the basis of the military airport
Salsk	Salsk-2 is a functioning airfield of civil aviation. Located on the southern outskirts of the city of Salsk. It is used for aerial work. Its reconstruction is planned in accordance with the "Development Strategy of the Transportation Complex of the Rostov Region until 2030"
Armavir	"Armavir" airfield of the 4th class, without hard surface, is capable of serving light aircraft and helicopters of all types. Passenger transportation is not carried out. There is also a military airfield near Armavir.
Millerovo	The military airfield is located in 5 km to the north-west of the city of Millerovo in the Rostov region, Not used for civilian transportation. On the north-eastern outskirts of Millerovo there is a landing ground for civil aviation "Millerovo", which is used for aviation works.
Michurinsk	General-purpose aerodrome. Short runway (1000 m). Half of the runway is in poor condition
Ruzaevka	Located in 26 km from Saransk. On February 14, 2018 the airport of Saransk received the first regular flight after its reconstruction for the World Cup Championship in 2018
Bryansk	A functioning airport, the classification number of runways 24/R/B/w/T with the necessary number more than 27. Requires reconstruction of the runway, modernization of equipment and building of ground infrastructure. The airport’s reconstruction is included in the Federal Program for Transport Development in 2018-2020
Tambov	The characteristics of the airstrip of the functioning airdrome “Donskoye” – 10/ R/c/w/T with the necessary number more than 27
Tula	Klokovo is a military airfield on the northern outskirts of the city of Tula. In the civil part of the aerodrome there is a landing site “Tula”, which receives helicopters of all types, as well as light and ultra-light aircraft
Orel	It does not function since 2010, because it was excluded from the State Register of Civil Aerodromes of the Russian Federation (closed down temporarily)
Ryazan	The civil airport Turlatovo is used for the training of parachute jumpers. In the distant future it is planned to reconstruct the Protasovo airport for civil air traffic
Sizran	Belongs to the Ministry of Defense. Used for the training of cadets of the Syzran Higher Military Aviation School (SVAShP).
Vladimir	“Semyazino” airport. The maximum take-off weight of an aircraft is 25 tons. Classification number of the airstrip is 28/F/D/X/T. In 2017 flights were carried out on Embraer 145 aircraft of the airline “Komiaviatrans”
Smolensk	Test aerodrome of the 1st class in the city of Smolensk, located in 3 km north of the Smolensk railway station. In 2009-2010 the aerodrome was occasionally used to receive civilian aircraft with one-time permits
Vologda	A functioning airport, classification number of the aerodrome’s runway 13/R/B/X/T, for the operation of the aircraft SSJ-100 more than 27 is needed

Table 13
The distribution of passenger transportation by distance in 2016

Indicator	Up to 500	501–1000	1001–1500	1501–2000	2001–2500	Total
Passenger transportation by two modes of transport in 2016, cumulatively	47,7	90,3	121,5	134,2	141,0	159,0
The share in total volumes of passenger traffic, %	30	57	76	84	89	100
Air passengers in 2016, cumulatively	1,9	14,6	34,6	41,9	46,8	56,3
The share in total volumes of passenger traffic, %	3	26	61	74	83	100
Passengers of railway transport in 2016, cumulatively	45,8	75,8	86,8	92,2	94,2	102,6
The share in total railway and air transportation, %	45	74	85	90	92	100
Specific weight of air transportation, %	4	16	28	31	33	35

In transportation at a distance of up to 500 km the share of air transport accounts for 4% and in the range of distances up to 1000 km – 16%, in the range of distances up to 2500 km the share is 33%.

At a range of over 2501 km 9,5 million passengers are transported by air transport and about 3 million passengers – by railway. The share of air transportation reaches 80%. For long distances of over 5000 km 99% of passengers are transported by air.

The airports of Moscow function as transfer nodes. Domestic air transportation is concentrated on routes to Moscow and from Moscow (75%). Flights without intermediate landings will become economically viable with increasing traffic volumes and loading capacities of passenger flights on long-distance routes.

It is possible to unburden the airports of Moscow if a network of hub international airports is developed on the country's territory.

The airline tariffs exceed the railway ones (when traveling in compartment cars) on short distances (up to 1000 km) and on routes to hard-to-reach areas where there is no competition with the modes of land transportation. The high tariff rates of air travel for short distances are related to certain specific features: the main resources are spent on takeoffs and landings, planes have a relatively smaller payload and higher unit costs. These factors are not taken into account in the adopted algorithm for the formation of airport charges.

An increase in air transportation is influenced by:

- the growth of demand for passenger air transportation on the developed routes due to the increase of the population's well-being, business activity and investments in the development of the economy;
- the development of regional transportation, the opening of new routes or restoration of the closed ones, which would be possible with a large-scale reconstruction of aerodromes, including those mentioned in Table. 12.
- according to preliminary estimates, the potential for the growth in air transportation in the range of distances up to 2000 km, with the transition from the railway transport to air transport of a part of passengers is 20 million passengers.

The development of regional traffic is possible on the condition of modernization of regional airfields and changes in airport charges taking into account the specifics of short-distance flights.

REFERENCES

1. AIP of Russian Federation// FSUE «Centre of aero-navigation information». URL: <http://www.caiga.ru/common/?lang=ru>.
2. Population activity in usage of transport services. Bulletin of social and economic crisis in Russia (2015)/Under the guidance of L. Gryhoriev, A. Goliashhev, A. Lobanova and others // Analytical center affiliated to the Government of Russian Federation. № 7. 22 c. URL: <http://ac.gov.ru/files/publication/a/7059.pdf>.
3. Analytical reviews of A. Fraiman ([b.g.]) // Institute of automatized technologies for the air transport. URL: <http://www.iatvt.ru/index.cgi?doc=11>.
4. Base of airdrome ([b.g.]) // Interregional public organization of pilots and citizens – owners of aerial vehicle (RASPA). URL:<http://maps.aopa.ru>.
5. Annual report 2016 //Russian Railways. URL: <http://ar2016.rzd.ru/pdf/ar/ru/ru-annual-report-pages.pdf>.
6. Diagram of flexible regulation of tariffs for passengers' transportation for long distances in trains of JSC «FPK», bound within the state in 2018: in sleeping and general cars (using the passengers' cars of locomotive traction), as well as in multiple unit // Russian railways. URL: http://pass.rzd.ru/static/public/ru?STRUCtURE_ID=5106.
7. *Iliin I.P., Maskaieva Y.Y.* (2016) Price competition of air and railway transport // Association «Zheldorrazvitiie». URL: <http://zdravzvitie.ru/analytics/publikatsii/tsenovaya-konkurentsia-vozdushnogo-i-zheleznodorozhnogo-transporta/>.
8. Information on transportation between the flight points 2015–2016. Statistical anthology (2016) // Transport and clearing-house. URL: https://arch.tch.ru/statistics/coll_citypairs
9. Calendar of low prices ([b.g.]) // Aviasales.ru. URL: <https://www.aviasales.ru/calendar>.
10. *Nesterov Y. V., Fraiman A. B.* (2014) Paradigm of strategy of air transport control // Transport of Russian Federation. № 2 (51). C. 24–29. URL: <http://www.rostransport.com/transportrf/archiv/510/>.
11. On approval of tariff guide № 4, book 3 «Tariff distance between transit stations of railways of federal railway transport»: Order of Ministry for traffic connection of RF dated 15.07.2003 № 55 (reading dated 18.03.2011) // Russian Railways. URL: http://doc.rzd.ru/doc/public/ru?STRUCtURE_ID=704&layer_id=5104&refererLayerId=5103&id=2060.
12. Passenger transportation 2016 // RR. URL: http://www.rzd.ru/static/public/ru?STRUCtURE_ID=5227.
13. Passenger transportation and passenger turnover for 2016–2017 // Federal agency for air transport (Rosaviation). URL: <http://www.favt.ru/dejatelnost-vozdushnye-perevozki-perevozki-passazhirov/>.
14. Order of FTS of Russia dated 27.07.2010 № 156-т/1 (reading dated 23.12.2016) «On confirmation of tariffs, fees and charges for works (services), related to passengers, luggage and cargo-luggage transportation by railway transport of general use within state transport connection and run of passenger cars performed with the long-distance trains of OJSC «Russian railways», OJSC «Federal passenger company», OJSC «Passenger company «Sakhalin», OJSC «JSC «Railways of Yakutia» and for works (services) on usage of infrastructure of railway transport of general use, provided by OJSC «Russian railways», OJSC «JSC «Railways of Yakutia», for these transportation, prices (tariffs) for works (services) on usage of infrastructure of railway transport of general usage, Provided by OJSC «Russian railways» performing the passengers, luggage and cargo-luggage transportation by railway transport of general use in commutation service in subjects of Russian Federation, and rules of their implementation (Tariff guide)» // Cunsultant Plus. URL: goo.gl/nnrc2z.
15. Routing directory for air traffic service of Russian Federation // FSUE «Centre of aeronavigation information». URL: http://www.caiga.ru/DocAni/manual_of_path_ovd/manual_ovd/ATS_Routes_Manual_07-12-2017.pdf.
16. Rates of fees of RF airports// Transport and clearing house. URL: <http://cstweb2.tch.ru/info2/index.html>.
17. Transport of Russia. 2016. January-December // Ministry of Transport of Russian Federation. URL: <https://www.mintrans.ru/documents/7/7249>.
18. *Yurkivich M., Kazunina A.* (2013) Analysis of market of passenger transportation for the long distance (with the example of city of Moscow) // logistics. № 6. P. 20–24. URL: <http://www.logistika-prim.ru/articles/analiz-rynka-passazhirskikh-perevozok-v-dalнем-soobshchenii-na-primere-g-moskvy>.
19. National Transportation Statistics 2016 // Bureau of Transportation Statistics, U. S. Department of Transportation. URL: http://www.bts.gov/publications/national_transportation_statistics/
20. Performance of Passenger Transport expressed in passenger-kilometre: European commission Directorate-General for Mobility and Transport- Statistical pocketbook 2017 // European commission. URL: https://ec.europa.eu/transport/facts-fundings/statistics/pocketbook-2017_en.