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HSR Development in Russia Considering the Dynamics of Passenger Traffic and Public Opinion

Ivanova, Elena A., *Russian University of Transport, Moscow, Russia.*
Flyagina, Tatyana A., *Russian University of Transport, Moscow, Russia**

Elena A. IVANOVA **Tatyana A. FLYAGINA**

ABSTRACT

To study the problems and opportunities for implementation of high-speed railway (HSR) projects, as well as to confirm the potential demand for high-speed transportation services, the authors studied public opinion regarding three of the potential HSR lines as well as the experience of foreign countries in implementation of projected passenger traffic, financing of construction of high-speed main lines and assessing their impact on the general economic growth of regions.

When conducting the study, the authors used the methods of a questionnaire sociological survey, analysis, comparison, induction.

The main results of the study have shown that in development and implementation of expensive high-speed rail projects, it is of particular importance to identify the demand of passengers for high-speed transportation, the general attitude and readiness of the population of countries to use such main lines. The article has studied the dynamics of demand for passenger transportation by branded and non-branded trains on key directions, which made it possible to identify several of them as the most promising for development of high-speed lines. The sociological research carried out by the authors, using the method of questioning in social networks, made it possible to reveal the attitude of the country's residents towards the most potentially promising for high-speed rail projects directions: Moscow–St. Petersburg, Moscow–Kazan and Moscow–Rostov-on-Don. According to the results of the survey, Russians have a positive attitude to development of high-speed railways in the country, most of the respondents intend to use them when it is necessary to make interurban trips, especially on Moscow–St. Petersburg route.

The authors present the external economic effects and risks of development of high-speed railways in Russia. The effects comprise the growth of the population's transport mobility. The potential risks of developing high-speed rail projects are associated with complexity of ensuring reliable operation of rolling stock and infrastructure of these main lines under difficult climatic conditions in Russia, as well as with high cost of travel for Russians, which negatively affects demand. To overcome the latter risk, it is important to form a positive image of projects by modelling public opinion.

Keywords: railway, high-speed main lines, passenger transportation, modelling of public opinion, economic effects.

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*Information about the authors:
Ivanova, Elena A. – Ph.D. (Eng), Associate Professor at the Department of Transport Economics and Management of Russian University of Transport, Moscow, Russia, suntown@bk.ru.
Flyagina, Tatyana A. – Ph.D. (Economics), Associate Professor Department of Transport Economics and Management of Russian University of Transport, Moscow, Russia, t_flyagina@mail.ru

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For the original Russian text of the article please see p. 248.

Background.

The destiny of high-speed railways (HSR) construction projects in Russia remains the subject of increased attention of the public, business, and the scientific community. The main problems are associated with the high cost of projects and coordination of investment sources. At the same time, in several countries, for two decades, there has been a gradual development of high-speed passenger traffic. Except for few cases of unsuccessful commissioning of rolling stock, no country, having once decided to develop high-speed rail, has refused to it.

Methods

The study of the possibilities and effects of creating high-speed railways in Russia is based on a desk study of the experience of their development in other countries, on the analysis of secondary statistical data on operation of passenger transport in the Russian Federation, methods of comparison and induction, as well as on a sociological survey conducted in social networks.

Study objectives

The objective of the study presented in the article is to analyse the existing problems and opportunities for implementation of high-speed rail projects, public opinion, as well as the effects that will be obtained from implementation of high-speed transportation on the territory of the Russian Federation.

The authors have analysed the dynamics of transportation by express trains in the Russian Federation, generalised the existing international experience in development of high-speed transportation, studied projects for construction of high-speed trains in the Russian Federation and problems of their implementation. Empirical data from a survey on the intention of residents of the country to use high-speed trains on routes of their proposed commissioning were obtained. By means of inductive reasoning, general conclusions were obtained on the preferred direction of development of high-speed railways, on the need to model a positive public opinion about them and on the effects that will arise during implementation of the corresponding projects.

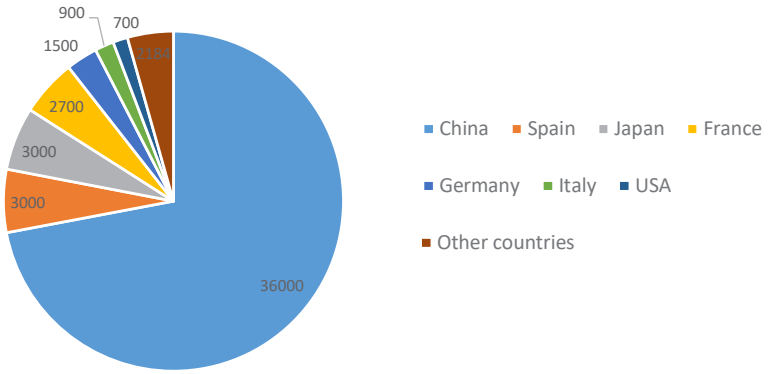
Dynamics of high-speed transportation in the world

The rapid increase in the length of HSR in several countries around the world has somewhat slowed down in recent years. As far as the countries of the European Union (EU) are concerned, despite 30 high-speed infrastructure projects between the countries and inside some EU countries, several of them have already been delayed by at least a year. According to data of European Court of Auditors the analysis, conducted in 2018 and covering more than 5,000 km of HSR across six EU countries – Austria, Germany, France, Italy, Portugal, and Spain – revealed that trains currently run at around 45 % of their potential velocity. The report says that high-speed railways on the continent are delivering «low-added value». The six aforementioned countries received 83.5 % of all EU funding for high-speed lines [1].

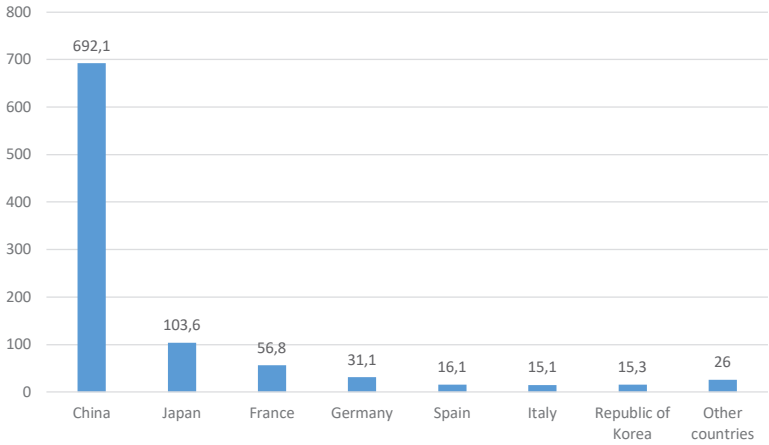
The total length of high-speed railways in the world has exceeded 52,4 thousand km by 2020, while about 12 thousand km were under construction, total passenger turnover exceeded in 2020 956 milliard passenger • km. China is the undisputed leader according to those indicators (Pic. 1) [2]. Besides China, large projects for development of high-speed rail, aimed at increasing transport mobility of the population, the transit capacity of railways, reducing environmental pollution thanks to attracting passenger flows to public transport, are currently being implemented in Turkey, Spain, Italy, Great Britain, Austria, and other countries [3]. It is also reported about the construction of HSR in India, Iran, Poland, and many other countries [4; 5].

The cost of HSR projects, especially of pilot ones, is very significant, and without government subsidies, as well as without an interested investor, their construction is possible in some, but not all, countries, and not on all initially selected routes.

The payback periods of projects are different. In PRC, the five busiest lines managed to make a profit in the first three to five years. Thus, Beijing–Shanghai HSR after three years of operation (2015–2018) has become highly profitable and, according to preliminary estimates, will pay off in 15 years. The payback of HSR connecting cities in the peripheral regions of China is expected in the longer term. To effectively manage profitability of transportation on the Chinese HSR, dynamic pricing is used [6]. At the same time, in China, construction of HSR is viewed as a measure to stimulate economic growth,



Pic. 1 a. Length of HSR in the leading countries, 2020, km [2].



Pic. 1b. HSR passenger turnover in the leading countries, 2020, milliard passenger•km [2].

transfer of technology, and to create a single economic space both within the country and with foreign countries.

Since 2015, China and the countries of Southeast Asia have been promoting the construction of the Pan-Asian Kunming (China)–Singapore HSR with a length of more than three thousand km, passing through the territories of Laos, Vietnam, Cambodia, Thailand, Malaysia, with branches to the territory of Myanmar. The cost of the project is estimated at more than $75 billion, with a significant share of Chinese private and budgetary investments [7].

The implementation of such a large international project is associated with many economic and political risks, including the need to reconcile the positions of the countries involved, to consider economic climate in the region, external interference, and activities of contractors, etc. [8]. But despite the high cost and some problems with implementation of the project, the Government of China, as soon as Kunming–Singapore HSR is commissioned, expects significant revenues to the state budget from both passenger traffic and business development in China's border areas adjacent to the main line, and intensification of trade with the countries of Southeast Asia.

In the USA, development of high-speed rail is paid great importance at the federal level because of congestion of highways and the overloaded capacity of airports serving domestic routes [9]. Express trains are already operated in the corridor (called the Northeast Corridor (NEC)) linking Washington, New York, and Boston. The construction of HSR in California (1300 km) has also started, but opposition from opponents to the project and controversial legal and economic issues regarding this highway remain. The implementation of other projects (in Florida, in the Midwest of the country, etc.) is constrained by unresolved problems with finding investors and conflicts of interest in coordinating projects for which it is supposed

Table 1

Dynamics of transport expenses of the population of Russia, % *

Index \ Year	2005	2010	2016	2017	2018	2019
Share of the expenses of the population spent to pay services provided by public transport, %	2,9	3,1	2,4	2,3	2,3	2,3
Transport expenses of population (including private and public transport) on average per a member of a household, roubles per month	516,3	1511,7	2135,8	2686,9	2894,6	3094,1

Compiled by the authors based on the data of Federal State Statistics Service [12].

to attract private funding [3]. Problems with attracting investors to construction of HSR lines are typical of many countries. In France, there were difficulties with implementation of construction of a line from Paris to Charles de Gaulle airport [10].

There are different variants of financing development of HSR in the Russian Federation which are being studied: direct participation of the state in investment activity, private-public partnership, co-financing of projects with budgetary funds of several states (e.g., participation of China had been discussed), granting of concessions to Russian and foreign investors upon the results of public auctions (auctions and competitions) [11].

Dynamics of passenger transportation in the Russian Federation and HSR projects

In the Russian Federation in 2019 about 9 % of population's expenses were linked to transport, including use and purchase of vehicles (6,7 %), payment for services provided by public transport (2,3 %) (Table 1, [12]). The value of transport expenses is gradually growing, while the expenses for travels with public transport are relatively stable. In rapidly developing countries, the share of expenses of households on public transport is higher (about 4 % in China and Brazil, about 7 % in Mexico). In the developed countries, on the contrary, its share is lower: 2,5 % in Germany, 2,6 % in France, 2,4 % in Australia, 1,2 % in the USA, 1,1 % in Poland. The inhabitants of the USA spend about 9,3 % of the household budget on purchase and maintenance of private vehicles, in Germany this figure is about 13,8 %, in France – 14,2 %, Mexico – 18,4 %. The data for foreign countries is calculated by the authors based on OECD 2019 statistics [13].

The total expenses of the inhabitants of Russia linked to public transport have increased by 15 % during January to September period 2020 regardless the pandemic. The expenses have grown in 2020 as compared to 2019 regarding taxi services, car sharing, lease of electric scooters, while the expenses for metro, bus, trolleybus trips, as well as for car leasing are decreasing (by 45 % in 2020 as compared to 2019). The share of expenses for travelling in city buses, trolleybuses, metro constituted about 19 % of total expenditures linked to the use of public transport [14].

To reasonably choose directions for development of express and high-speed traffic, it is logical to start from the data of the analysis of the dynamics of passenger traffic volumes through the existing network (Table 2, Pic. 2), dynamics and sources of emerging income (Pic. 3). The largest increase in traffic volumes for the period from 2014 to 2018 was observed on the directions Moscow–St. Petersburg (167,71 %), Moscow–Nizhny Novgorod (158,54 %). In the same period, there has been a significant increase in the number of passengers carried on the routes Moscow–Bryansk (139,80 %), Moscow–Belgorod (138,40 %), Moscow–Saratov (123,90 %), Moscow–Kursk (123,42 %), Moscow–Voronezh (122,22 %), Moscow–Kazan (119,48 %) (data of Compass ACS of JSC Russian Railways).

The data on the passenger trips since the start of operation of express electric trains calculated as of January 1, 2019 are shown in Pic. 2.

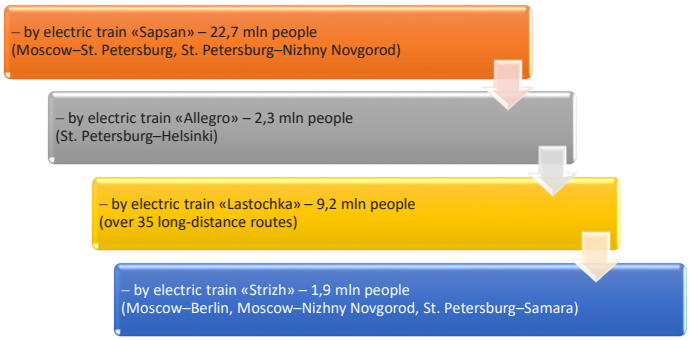
The analysis of the passenger traffic market on Moscow–St. Petersburg route showed that the total volume of traffic in 2018, excluding road transport, increased by 13,4 % (1,86 mln pass.) compared to 2017 and amounted to 15,75 million pass. At the same time, the volume of transportation by Sapsan trains increased by

Table 2

Main indicators of passenger transportation using the infrastructure of JSC Russian Railways*(compiled by the authors)

Indicator	2015	2016	2017	2018	2019
Passenger turnover, bln pass.-km	120,6	124,6	122,9	129,4	133,5
Suburban traffic, bln pass.-km	31,1	31,1	31,3	33,1	34,2
Long-distance traffic, bln pass.-km	89,6	93,5	91,0	96,3	99,2
Including speed and high-speed traffic			6,1	7,3	
Passengers departed, mln people	1 025	1 040	1 117,9	1 157,2	1 198,0
Suburban traffic, mln people	967,2	922,5	1 015,7	1 046,9	1 081,5
Long-distance traffic, mln people	103,1	97,8	102,2	110,3	116,5
Including speed and high-speed traffic			12,4	15,6	
Including by high-speed trains of JSC FPC	3,4	3,9	7,0	9,4	

*Data of annual reports of JSC Russian Railways and JSC FPC.



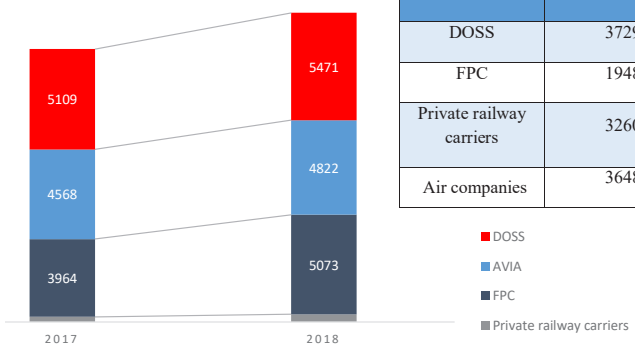
Pic. 2. Volume and routes of passenger transportation by express electric trains on the territory of the Russian Federation* (compiled by the authors). *Data of annual reports of JSC Russian Railways and JSC FPC.

7 % (0,36 mln pass.) and amounted to 5,47 mln pass., with an average ticket price of 3 729 rub. Pics. 3 and 4 show the analysis of the market on Moscow–St. Petersburg route.

Since the launch of Sapsan electric trains in 2009 on Moscow–St. Petersburg route, the traffic volume has grown from 1,62 mln pass. in 2010 to 5,47 mln pass. in 2018. At the same time, the share of Sapsan electric trains in the total traffic by all modes of transport as of 2018 was of 33,1 %. Pic. 5 shows the dynamics of passenger traffic on all types of transport between two capitals.

Pic. 6 shows average ticket prices on Moscow–St. Petersburg route as per carriers in 2018.

The transit capacity of the current schedule of Sapsan electric trains is 5,94 mln passengers, while the transportation volume in 2018 was of 5,47 mln people. The average population of electric trains in 2018 was 92,1 %, while during peak periods the population of trains exceeded



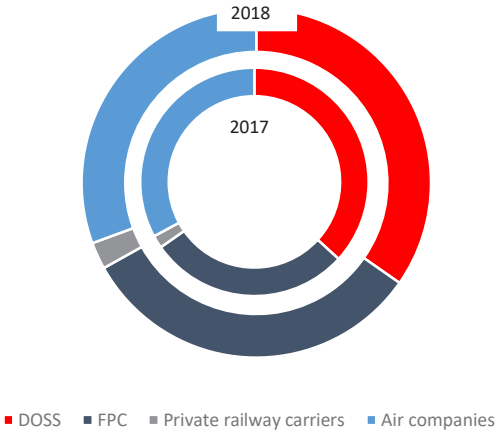
Carrier	Average bill in 2018, rub.
DOSS	3729
FPC	1948
Private railway carriers	3260
Air companies	3648

Pic. 3. Dynamics of departed passengers as per carriers in 2017–2018, thous.pass.* (compiled by the authors). *Data of annual reports of JSC Russian Railways and JSC FPC.

110 %, which already reflects a shortage of seats. The size of the current Sapsan electric train fleet of 16 does not allow for an increase in the offer of seats, and, therefore, management should consider purchasing an additional batch of Sapsan trains to meet the growing demand for high-speed railway transportation. And such decisions have already been made: in 2019, the holding company signed a contract for purchase in 2022–2023 of 13 Sapsan trains for the price of 1,1 bln euros.

Pic. 7 shows a diagram of intercity routes selected according to the criterion of the maximum number of passengers carried in 2018. The thickness of the lines reflects the density of passenger traffic. As it can be seen in the Pic. 7 the most important passenger turnover is observed on Moscow–St. Petersburg route, the routes between Moscow and Nizhny Novgorod, Moscow and Sochi, Moscow and Ekaterinburg, St. Petersburg and Ekaterinburg are also sufficiently popular.

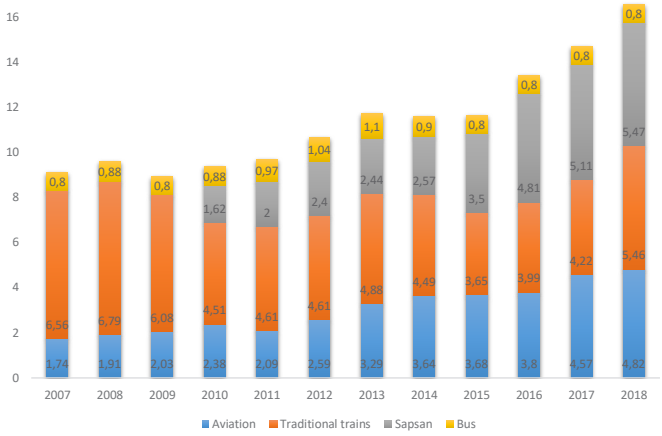
The share of direct income from passenger transportation prevailed in the structure of income from long-distance passenger transportation (91,34 %) in 2018. At the same time, there is a trend towards an increase in



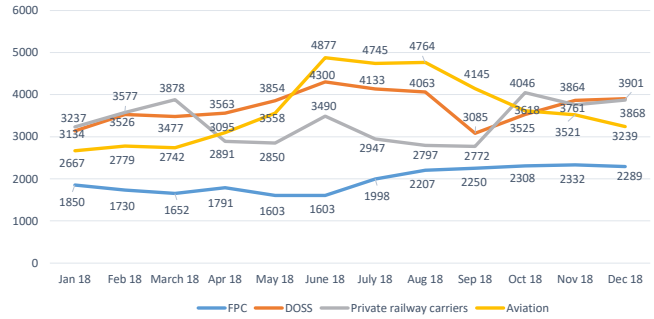
Pic. 4. Distribution of shares of carriers as per departed passengers in 2017–2018, %* (compiled by the authors). *Data of annual reports of JSC Russian Railways and JSC FPC.

income from the sale of additional services, and that indicates the importance for passengers of quality of the service provided on the train.

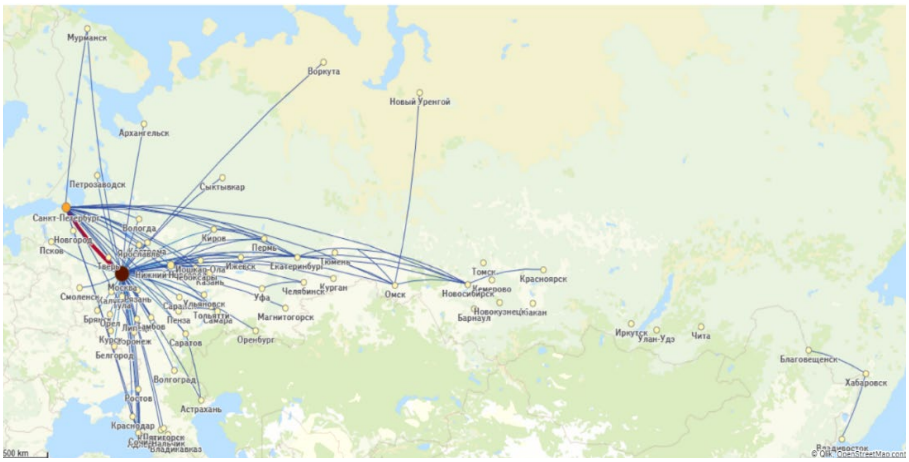
Let us examine the dynamics of income collected by Russian Railways holding company from passenger transportation in different categories of trains (data from Compass ACS of Russian Railways) For the period from 2014 to 2018 the growth of income from



Pic. 5. Dynamics of passenger flow on all modes of transport between two capitals, thous. persons* (compiled by the authors). *Data of annual reports of JSC Russian Railways, JSC FPC and Federal Agency of Civil Aviation.



Pic. 6. Average cost of a ticket on the route Moscow–St. Petersburg as per carriers in 2018, roubles* (compiled by the authors). *Data of JSC Russian Railways and Internet services for air tickets sales.



Pic. 7. TOP-100 of domestic intercity routes as per the number of passengers transported by railway transport in 2018* (compiled by the authors).
****Data for analysis were provided by the High-Speed Transportation Directorate, branch of JSC Russian Railways, the analysis was carried out by the authors using software, developed in the Institute of Economics and Finance of Russian University of Transport.***

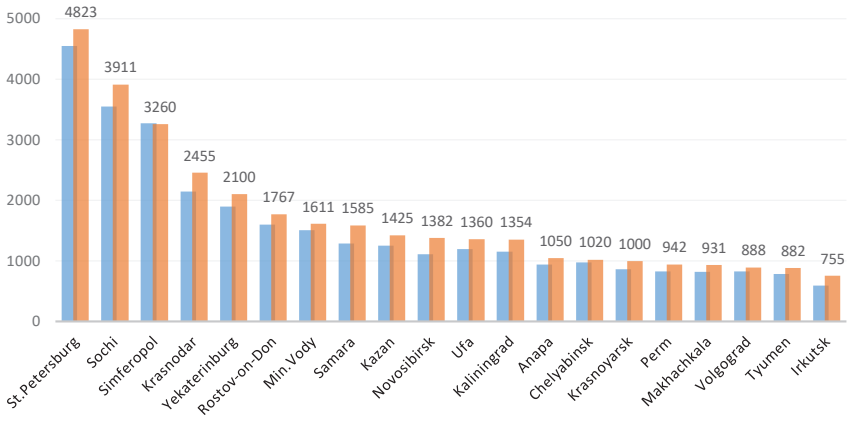
transportation in branded trains was ensured, first of all, on the routes Moscow–St. Petersburg (grown by 1,79 times), Moscow–Kazan (2 times), Moscow–Voronezh (1,34 times) and Moscow–Saratov (1,19 times), while revenues from transportation in non-branded trains showed a growth trend on the routes Moscow–Nizhny Novgorod (4 times), Moscow–Bryansk (3 times) and Moscow–Belgorod (2,78 times). The results of the analysis of the dynamics of passenger traffic on the routes, on the one hand, can be considered as the basis for placing different categories of express trains on the marked routes (trains including cars of increased comfort for routes Moscow–St. Petersburg, Moscow–Kazan, Moscow–Voronezh, etc, economy class cars for Moscow–Nizhny Novgorod, Moscow–Bryansk routes). On the other hand, on routes where passengers manifest a growing demand for transportation in trains with a high level of service, it is logical to study feasibility of organising high-speed transportation.

According to statistics, the main «contenders» for construction of HSR remain the routes Moscow–St. Petersburg (JSC Russian Railways conducts engineering surveys and development of project documentation of the route based on the instruction of the President of the Russian Federation of April 2019 No Pr-623; in December 2020 scientific and engineering council of JSC Russian Railways suggested that the Moscow–St. Petersburg HSR passes through Veliky Novgorod [2]; Moscow–Kazan (the route is mentioned in the Comprehensive plan for development and expansion of trunk infrastructure of 2018 [15]); the southern route Moscow–Voronezh–Rostov-on-Don–Sochi [16] seems also to be promising since in the summer months there is a high demand for passenger transportation. Considering the existing objective difficulties due to surface topography for development of high-speed railway infrastructure on Rostov-on-Don–Sochi section, while conducting the survey the authors in the latter case asked question about Moscow–Voronezh–Rostov-on-Don section only.

According to the data of the Centre for Strategic Research «Platform XXI», the most significant directions of passenger transportation from the capital of the Russian Federation by air in 2018 were (Pic. 8): Moscow–St. Petersburg (4,8 mln pass.), Moscow–Sochi (3,9 mln pass.), Moscow–Simferopol (3,3 mln pass.), Moscow–Krasnodar (2,5 mln pass.) [17].

The largest increase in the number of passengers carried was recorded in the period under review on the routes Moscow–Sochi (+362 thousand people or 10,2 %), Moscow–Krasnodar (+307 thousand people or 14,3 %), Moscow–Samara (+299 thousand people or 23,3 %), Moscow–St. Petersburg (+275 thousand people or 6,1 %) [17].

The experience of China shows that introduction of HSR on a route allows switching to railway transport from 30 to 50 % of



Pic. 8. Change in the volume of transportation on the main routes of air transport in 2017–2018, thous. people [17].

passenger traffic from parallel air routes [7]. In addition, construction of a dedicated HSR on a route with the existing capacity limitations contributes significantly to an increase in the number and average speed of freight trains.

Considering the positive dynamics of demand for air and railway transportation by branded trains on the routes Moscow–St. Petersburg, Moscow–Kazan (in the future Yekaterinburg), Moscow–Voronezh–Rostov-on-Don (in the future Krasnodar and then Sochi), the authors found it advisable to study the attitude of inhabitants of the country towards development of relevant HSR projects in the Russian Federation.

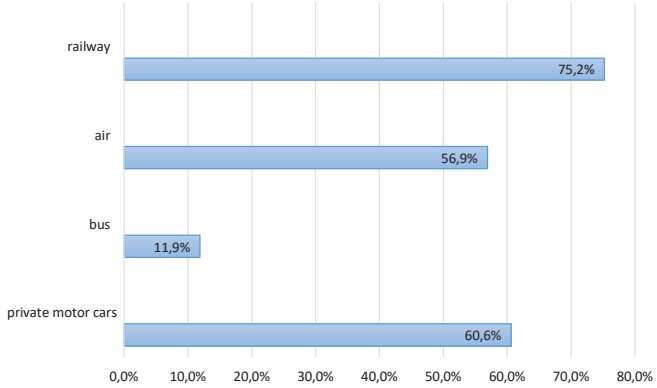
Studying the opinion of Russian residents about HSR projects in the country

To clarify social priorities and attitude of Russians to the projects for development of HSR, the authors proactively carried out a sociological survey in social networks. The questionnaire developed by the authors was posted in June–August 2020 in the popular social network VKontakte. The survey involved 545 people representing various categories of consumers of transport services, of which 56 % belong to the age group of 18–25 years, 23 % to 26–40 years old age group, 17,4 % to 41–65 years old people. This ratio of age groups allows us also to better understand the attitude to HSR projects of representatives of the generation, which will mainly use them after the launch of the main lines. The size of the sample of respondents allows us to consider the completed research as qualitative. The evaluation of statistical error was executed following the method of calculation of dichotomous variables: with confident probability of 95 % the confident interval was of 4,2 %.

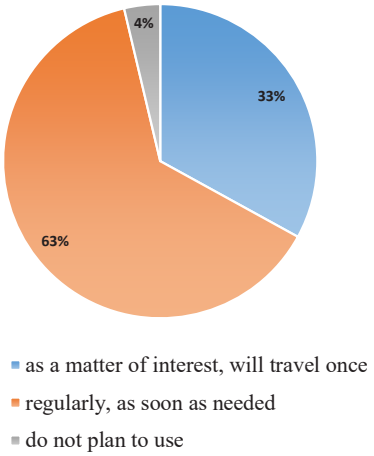
As can be seen from Pic. 9, the surveyed residents of Russia prefer railway transport for intercity travel, the second priority mode of transport for this group of respondents is air transport. At the same time, on the whole, the survey participants demonstrated a generally positive attitude towards the high-speed transport projects being developed. Of the total number of respondents, only 3,7 % of people answered that they did not intend to use HSR for intercity travel. At the same time, 63,3 % of the respondents intend to travel on HSR regularly as far as they have a relevant need (Pic. 10).

Among the survey participants, the highest priority is given to Moscow–St. Petersburg HSR, the second most attractive is Moscow–Kazan route. Regarding the direction Moscow–Voronezh–Rostov-on-Don, in the surveyed group there are more negative answers about the intention to use that HSR than positive ones (Pic. 11).

About 95 % of respondents intend to travel by high-speed trains on Moscow–St. Petersburg route. At the same time, 69,4 % of the respondents named personal goals as possible goals of the trip, and 59,3 % touristic ones (Pic. 12). Since the sample consisted mainly of young representatives of society, the small percentage of those who indicated business trips cannot be an indicative result of the study. However, judging by the answers of the respondents, they are ready to travel by high-speed trains, even for personal purposes.



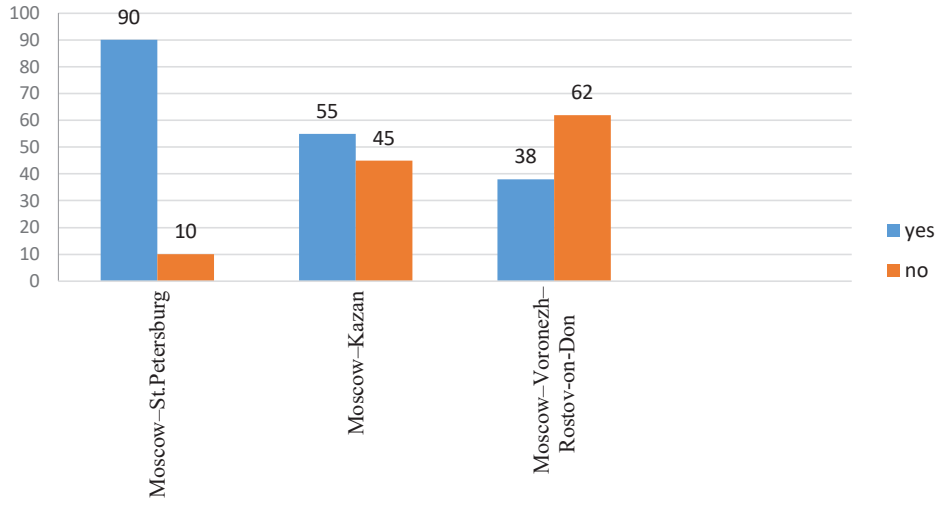
Pic. 9. Modes of transport preferred by survey participants for intercity trips, % of those who noted this mode of transport (compiled by the authors based on the results of a sociological survey).



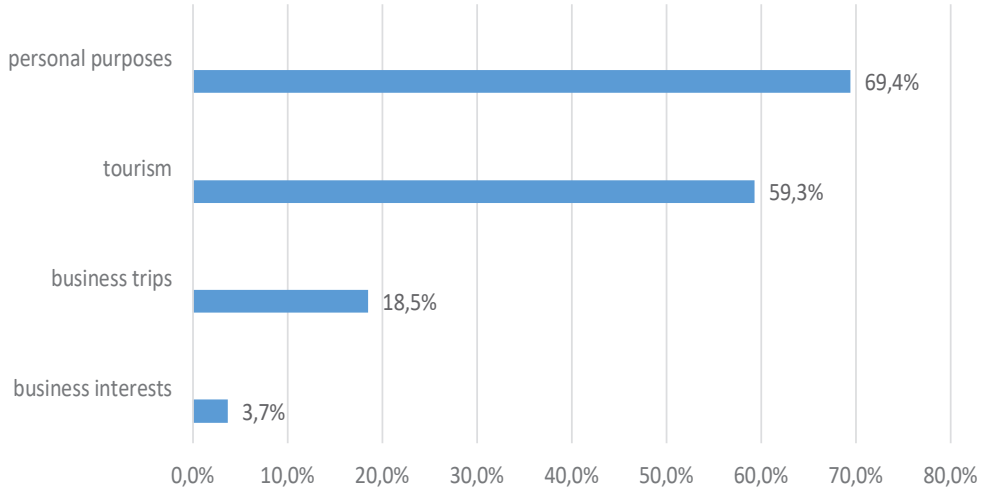
Pic. 10. Distribution of respondents' answers regarding the expected frequency of trips on HSR, %. Compiled by the authors based on the results of the sociological survey conducted.

The results of the sociological survey carried out by the authors allow us to make a qualitative conclusion about the positive attitude of the respondents to the projects for development of HSR in Russia, as well as the fact that the Moscow–St. Petersburg route attracted the most attention among three options. That corresponds to the statistics on growth of traffic on that route presented in Pics. 2, 5, 7 and allows us to conclude that it is advisable to consider this direction as a priority for construction of HSR.

At the same time, to obtain the maximum economic effects from the launch of high-speed traffic on Moscow–Kazan, Moscow–Rostov-on-Don and other routes, it will be necessary to develop a program for modelling a positive public opinion, mainly among the younger generation



Pic. 11. Distribution of answers of respondents about the intention to use HSR after its launch (option to mention a single or more directions), % (compiled by the authors based on the results of the sociological survey conducted).



Pic. 12. Purposes of trips in intercity traffic, indicated by the survey participants, % of those who noted these purposes (compiled by the authors based on the results of the sociological survey conducted).

of the country's residents. The advertised topics and public relations activities under such a program should be based on highlighting the benefits and the work being done by the government and transport companies to reduce the risks of construction of high-speed lines.

External economic effects and possible risks of development of HSR in the Russian Federation

Among the external effects from creation of HSR, the most important are, according to the authors:

• Development of the country's economy as a whole and of HSR gravity regions by increasing transport accessibility of regions.

• Growth of transport mobility of the population of the Russian Federation.

• Strengthening the social and territorial integrity of the Russian Federation.

• Increasing the competitiveness of Russia in the world market of transport services.

• Redistribution of population density from labour-surplus regions of the country to the regions of construction and operation of HSR.

• Regional convergence and levelling of incomes of the population [18].

• Development of tourism and cultural ties with areas gravitating towards HSR, due to the growth of transport accessibility.

• The emergence of additional opportunities for business development and attracting investments to the regions, including foreign ones.

• Innovative development of the transport industry and introduction of digital technologies and services in transport (blockchain, Big Data, digital communication systems based on the FDTD method, etc.) [19; 20].

• Integration of regions of gravity and expansion of trade exchange.

• Increase in capacity of railways to transport cargo after the construction of dedicated HSR.

• Reducing the negative impact of transport, primarily motor one, on the ecology of the regions [3].

The risk factors for implementation of HSR projects that can have a significant impact on the efficiency of projects are:

• High cost of high-speed transportation for the passenger.

• The required volume of investments in creation of HSR infrastructure.

• The level of capacity utilization (train population) and the volume of current operating costs.

• Technical reliability of rolling stock and infrastructure facilities of HSR under difficult climatic conditions of the Russian Federation.

• Meeting the localisation rate requirements regarding production of rolling stock for HSR, which, according to program documents, should be about 70–80 % [21].

Conclusion.

The development of high-speed transportation is of great social and economic importance for the Russian Federation.

While the amount of transport expenditures of residents in relation to other countries is average, several routes have a potential for growth in demand for express and high-speed transportation. The analysis of the dynamics of volumes and incomes from long-distance passenger transportation and the sociological survey carried out by the authors confirm the potential of Moscow–St. Petersburg route. As the experience of foreign countries summarised in the article shows, development of HSR creates several positive effects on the development of the economy of the regions and of the country. However, to generate the necessary demand for high-speed transportation along the projected mainlines, it is necessary to model a positive public opinion through implementation of a public relations program based on popularisation of economic and other effects arising from construction of HSR.

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