

Pandemic and sanctions as risk factors for the sustainable development of transport systems

Natalia Kataeva^{1*}, Alexey Sysolyatin¹, Darya Starkova², and Andrey Ivashchenko³

¹Vyatka State University, 610000 Kirov, Russian Federation

²Vyatka State Agrotechnological University, 610017 Kirov, Russian Federation

³Moscow architectural institute, 107031 Moscow, Russia

Abstract. This article analyzes approaches to determining external factors affecting the transport industry, as well as the degree of influence of the most significant factors, such as the Covid-19 pandemic and sanctions pressure, on passenger traffic. The development of the transport industry is influenced by various factors, both global and internal. At the same time, it can be noted that there is a correlation between these groups of factors, which makes it possible to weaken the negative pressure of one group of influence factors by strengthening the other group. Based on the application of monographic, economic-mathematical, statistical and expert methods, the indicators characterizing the transport industry are analyzed. The growth rates of indicators are calculated: passenger traffic, passenger capacity, passenger traffic growth index. The influence of external factors (pandemic and sanctions) on passenger transportation was determined using passenger traffic indicators and the passenger traffic growth index. It is concluded that the pandemic and sanctions have significantly affected the dynamics of passenger transportation and the transport industry as a whole. Moreover, the degree of influence of each of these factors is different. Using the example of air transportation, the global and Russian trends of the pandemic's impact on passenger traffic are determined.

1 Introduction

It is difficult to underestimate the impact of transport on the socio-economic development of any country. The transport sector is an important branch of the economy, it allows for uninterrupted transportation of goods and people.

The development of the transport industry is a significant condition for the stable functioning of the economy of any country. The transport industry includes such elements as transport infrastructure, transport logistics, and modes of transport. All these elements are influenced by external and internal factors, such as the geopolitical situation, economic sanctions, new transport technologies and innovations, international and national requirements for environmental friendliness of transport, peculiarities of legislation of individual countries and other factors.

* Corresponding author: Natalya-kataeva@yandex.ru

The purpose of the study is the analysis of trends in the transport industry, namely, to study the influence of external factors on the indicators of the transport industry, to assess changes in passenger traffic under the influence of two main factors: the Covid-19 pandemic and the imposition of sanctions.

John R. Meyer is considered to be the founder of the transport economy as a branch of the economy. At the same time, theoretical and methodological foundations and approaches to the study of phenomena and processes of the transport economy were considered in the works of foreign and russian scientists.

The impact of the COVID-19 pandemic and sanctions on the transport economy is considered in [1-5, 13, 15-17] (Kushnir, Shkodinsky, Dianova, Koryakov, Makar, 2022; Dahlman, Anund, 2022; Bandyopadhyay, Bhatnagar, 2022; Lu, Y. Fang, J.Fang, 2022; van Hassel, Vanelslander, 2022; Kuleshova, Kuskov, 2020; Makarov, Drobot, Avtsinova 2020; Novikova, 2021; Saiyyan, Ason, 2021).

Review of modern peer-reviewed sources [6-12, 14, 18-20] (Harris, Wang, Wang, 2015; Mironova, Ganieva, Rudaleva, 2022; Rosenko, Skrebets 2022; Hossain, Mozahem, 2022; Wójcikiewicz, Wagner, 2021; Budarina, Kazakova, 2020; Lazic, 2020; Fedorenko, Toymentseva, Tsegledi, 2020) showed, that the issues of transport economics, improving the efficiency of managing the value of cargo turnover in the conditions of reorientation of external cargo flows due to sanctions have not been studied enough at present.

2 Materials and methods

In order to study the trends of the transport industry, an analysis of the dynamics of changes in the number of passenger vehicles was carried out (table 1) and the number of passengers transported (table 2).

Table 1. Availability of passenger vehicles in Russia at the end of the year; thousands of pieces.

Passenger vehicles	2017	2018	2019	2020	2021	2021 in % to 2017
Public buses	170	166	166	159	144	84,71
Passenger cars – total	46 887	47 425	48 430	49 259	50 304	107,29
Including:						
Owned by citizens	44 792	45 377	46 292	46 926	47 689	106,47
Tram cars	7,7	7,7	7,7	7,6	7,4	96,10
Trolleybuses	9,4	9,0	8,7	8,0	7,9	84,04
Subway cars	7,8	8,1	8,7	9,0	9,0	115,38
Sea passenger and cargo-passenger transport vessels	54	54	49	46	47	87,04
River passenger and cargo-passenger transport vessels	1,7	2,2	2,6	2,6	2,7	158,82
Civil aircraft	7,0	6,9	6,9	7,0	7,1	101,43

According to Rosstat (table. 1) over the past five years, the number of river passenger and cargo-passenger vessels, the number of subway cars, the number of passenger cars and the number of civil aircraft have been increasing.

There is a decrease in the number of other types of transport, with the most significant decrease being traced to public transport (buses and trolleybuses). At the same time, the pandemic didn't have a significant impact on the number of vehicles. The changes are taking place in accordance with the current trend of increasing the share of cars in

ownership, which leads to a decrease in the demand for public transport, and to a reduction in the fleet of buses and trolleybuses consequently.

Table 2. Passenger transportation by public transport modes in the Russian Federation, million people.

Type of transport	2017	2018	2019	2020	2021	2021 in % to 2017
Transport - total	18 439	18 114	17 826	12 494	13 718	74,40
including:						
railway	1 121	1 160	1 201	876	1 059	94,47
bus	11 185	10 912	10 637	7 695	8 054	72,01
tram	1 327	1 259	1 240	889	992	74,76
trolleybus	1 376	1 263	1 148	760	808	58,72
metro	3 298	3 381	3 451	2 189	2 680	81,26
naval	12	8	6	5	5	41,67
inland waterway	13	12	11	8	9	69,23
airborne	108	118	131	71	112	103,70

For the period 2017-2021 (according to Rosstat), the number of transported passengers decreased in almost all modes of transport, with the exception of airborne. The most significant reduction in the number of passengers occurred in 2020, which is a global trend associated with the impact of the Covid-19 pandemic.

Over the past three years, two factors have had a significant impact on the transport industry in the world as a whole, and in Russia in particular: the Covid-19 pandemic and sanctions pressure.

For example, according to the Federal Air Transport Agency, the average passenger traffic of air traffic in 2020 decreased by 70% compared to 2019 at major European and Asian airports, and by 60% at American airports. In Russia over the same period, the situation is somewhat different (fig. 1) – there is a decrease in passenger traffic at major airports by an average of 40%, which may be due to less severe pandemic restrictions compared to other countries, as well as rapid mass vaccination.

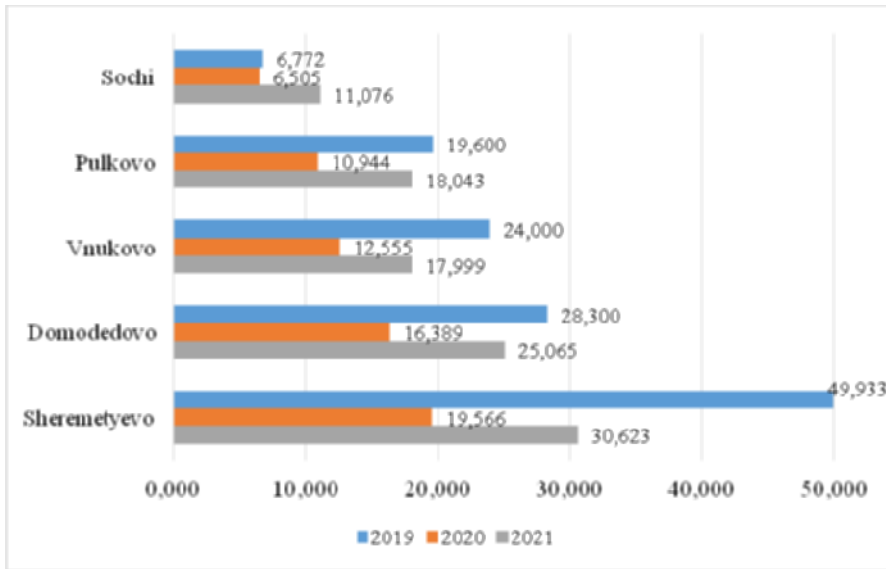


Fig. 1. Passenger traffic of major Russian airports, million people.

It should be noted that in 2021, only one Russian airport (Sochi) was able to improve the pre-pandemic indicators for passenger traffic, the rest of the airports could not reach the passenger traffic of 2019.

The theoretical and methodological basis of the research was the study of the main provisions of the transport economy, the interrelations between their elements on the basis of analytical and expert methods presented in domestic and foreign scientific literature.

It is proposed to using the following methods to assess the degree of influence of factors affecting passenger traffic:

- a method of expert assessments involving the analysis of expert opinions published in open sources;
- a method of statistical analysis based on determining the growth rates of indicators;
- an analytical methods based on the calculation of indicators such as passenger traffic, passenger capacity, passenger traffic growth index.

The indicator "passenger capacity" for various types of transport is proposed to be calculated according to the following formula 1:

$$P_i = K_i / I_i, \quad (1)$$

where P_i – passenger capacity of a certain type of transport;

K_i – number of passengers transported i - means of transport during the year;

I_i – number of vehicles i - type of transport at the end of the year.

The indicator «passenger traffic growth index» for various modes of transport is calculated as the ratio of passenger traffic in a certain month of the current year to the same indicator (in the same month) of the previous year.

The substantiation of the main provisions of the work concerning the identification of the degree of influence of the Covid-19 pandemic and sanctions pressure on passenger transportation in the country was carried out using the methods of traditional methods of deduction and induction, structural and functional analysis, abstract logical judgments and causal relationships, systematic and integrated approaches. The empirical part of the work is based on the usage of monographic, statistical and analytical methods of information analysis.

3 Results

The research of the impact of the most significant factors on passenger traffic consists of two parts: the study of the impact of the pandemic and the study of the degree of impact of sanctions.

The impact of the pandemic was assessed using two indicators: passenger capacity (table 3) and passenger traffic for all modes of transport in general (fig. 2), calculated on the basis of Rosstat data.

The impact of sanctions was assessed by the following indicators: passenger traffic (fig. 2) and passenger traffic growth index (fig. 2).

Table 3. Passenger capacity by type of transport in the Russian Federation, thousand people / unit of transport.

Type of transport	2017	2018	2019	2020	2021
bus	65,8	65,7	64,1	48,4	55,9
tram	172,3	163,5	161,0	117,0	134,1
trolleybus	146,4	140,3	132,0	95,0	102,3
metro	422,8	417,4	396,7	243,2	297,8
naval	222,2	148,1	122,4	108,7	106,4
inland waterway	7,6	5,5	4,2	3,1	3,3
airborne	15,4	17,1	19,0	10,1	15,8

During the analyzed period (table 3) the maximum passenger capacity of such a type of transport as the metro, trams are in second place, followed by naval transport. It should be noted that the pandemic has had a significant impact on passenger capacity, for all modes of transport there is a significant decrease in this indicator relative to its pre-pandemic values (2019).

It wasn't possible to achieve pre-pandemic passenger turnover indicators for all modes of transport generally in the first quarter of 2021, however, the situation has changed towards a significant increase in passenger traffic from April 2021. The possible reasons for this situation may be the following: a reducing the incidence of Covid-19 due to timely mass vaccination, an increase in the number of movements within the country as a result; the adoption of effective measures of state support for the tourism industry, whose activities directly affect the transport industry; an identification of the industries most affected by the Covid-19 pandemic and the application of state support measures to restore them, which also had an impact on the transport industry (transport logistics) and other factors.

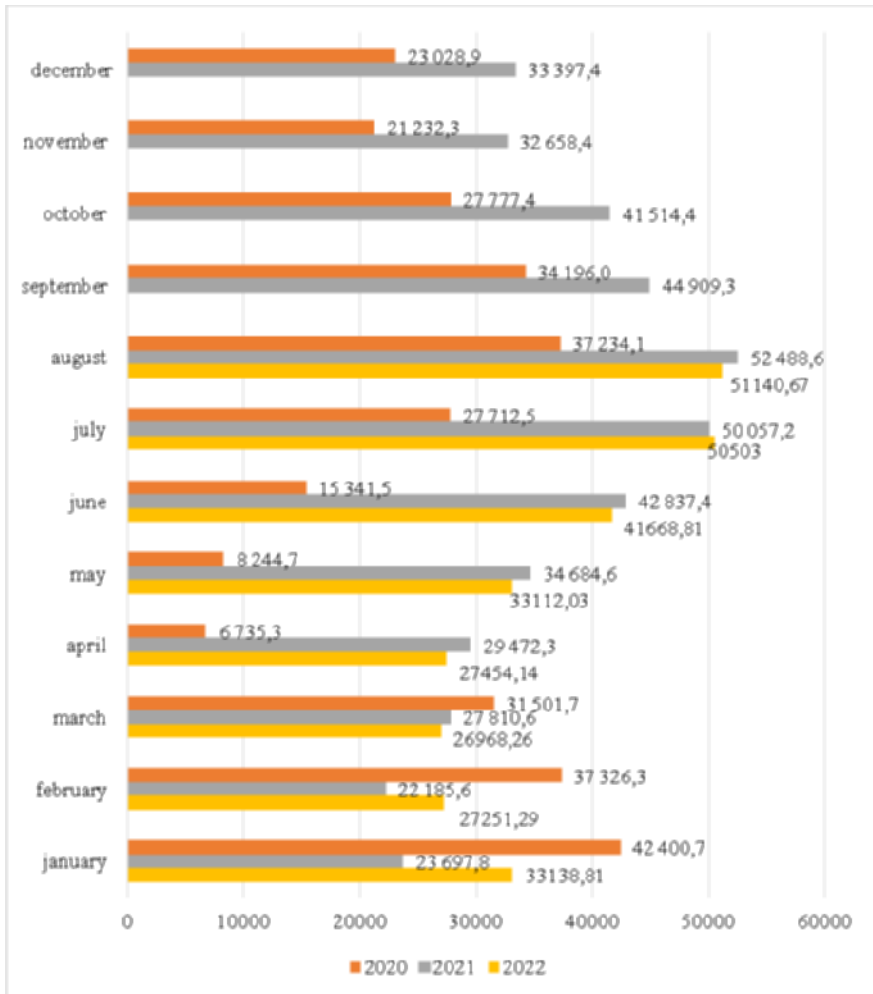


Fig. 2. Passenger turnover by means of transport in the Russian Federation, million passenger-km.

To assess the degree of influence on passenger turnover of such significant factors as the Covid-19 pandemic and sanctions, the passenger turnover growth index (Fig. 3) was calculated based on Rosstat data. The data for 2021 in the calculations were adjusted for the correction factor obtained by the ratio of passenger turnover in 2021 and the average annual value of passenger turnover before the pandemic (period 2017 – 2019).

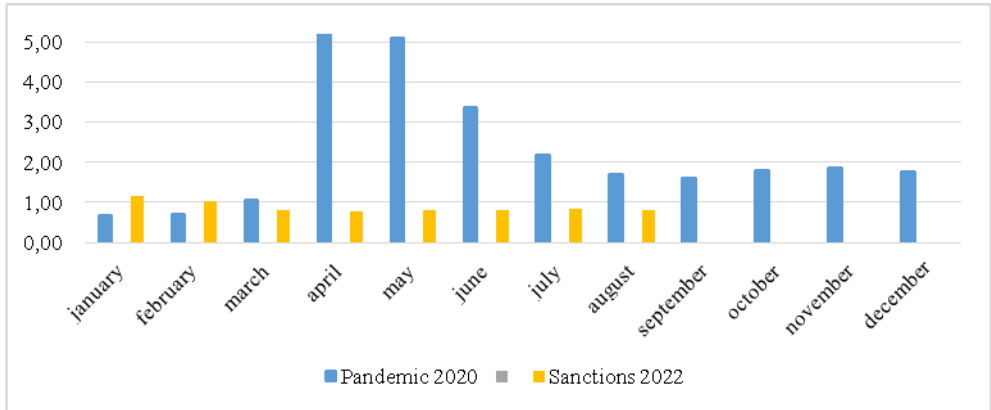


Fig. 3. The impact of the Covid-19 pandemic and sanctions on passenger turnover across all modes of transport in the Russian Federation.

As a result of the study, it was revealed that the Covid-19 pandemic had the strongest impact on passenger turnover. In almost all modes of transport, with the exception of inland waterway, there is a significant decline in passenger turnover under the influence of the pandemic. It should be noted that the increased sanctions pressure (starting from March 2022) has had an impact on the reduction of passenger turnover by air transport, while there is a trend of growth in passenger turnover by rail, inland waterway and sea modes of transport, which may be due to the development of domestic tourism and the action of the tourist cashback program.

4 Discussion

The economy of transport is a branch of the economy that has a significant impact on the socio-economic development of any country. The main element of the transport economy is vehicles that can be classified into the following groups of types of transport for the transportation of passengers: rail, public (bus, trolleybus, tram, metro), inland waterway, sea air; additionally, pipelines can be used for cargo transportation. Most modes of transport are suitable for simultaneous transportation of passengers and cargo, and at the same time there are specialized modes of transport that allow the movement of highly specialized products (for example, pipelines).

Since the beginning of the Covid-19 pandemic, the main problem of the transport industry in all countries of the world has been the problem of a significant reduction in passenger turnover, while cargo turnover indicators have not decreased so significantly. This trend is due to serious restrictive measures regarding the movement of citizens both inside and outside the country. Mass vaccination of the population of most countries and mutual recognition of vaccination certificates between countries, allowed to solve the problem of passenger transportation, the industry began to recover. Since March 2022, as a result of increased sanctions pressure against Russia in a number of countries, passenger turnover has decreased slightly. This was due to a reduction in passenger turnover outside the country, while passenger traffic within the country shows positive dynamics.

5 Conclusions

The development of the transport industry is influenced by various factors, both global and internal. At the same time, it can be noted that there is a correlation between these groups of

factors, which makes it possible to weaken the negative pressure of one group of influence factors by strengthening the other group.

The global factor such as the Covid-19 pandemic has had a significant impact on the transport industry of Russia, namely, the sphere of passenger transportation. In April 2020, passenger turnover by all modes of transport decreased by more than 5 times, in the following months, the impact of the pandemic on passenger turnover is decreasing, and starting from March 2021, there is a tendency to increase passenger turnover. State support measures have helped to reduce economic losses in the transport sector timely.

In 2022, due to increased sanctions pressure, the passenger turnover of the domestic transport sector demonstrates relative stability, and even an upward trend for some types of transport.

Based on the results of the study, it can be concluded that external and internal factors can have a mutual stabilizing effect on the transport industry.

References

1. A. Kushnir, S. Shkodinsky, T. Dianova, A. Koryakov, S. Makar, *Transportation Research Interdisciplinary Perspectives* **13** (2022) <https://doi.org/10.1016/j.trip.2022.100549>
2. A. S. Dahlman, A. Anund, *Journal of Transport & Health* **27** (2022) <https://doi.org/10.1016/j.jth.2022.101508>
3. A. Bandyopadhyay, S. Bhatnagar, *Transport Policy* **130** (2022) <https://doi.org/10.1016/j.tranpol.2022.10.014>
4. C. Lu, Y. Fang, J. Fang, *Journal of Innovation & Knowledge* **7**, 4 (2022) <https://doi.org/10.1016/j.jik.2022.100254>
5. E. van Hassel, T. Vanelslander, *Transport Policy* **128** (2022) <https://doi.org/10.1016/j.tranpol.2022.09.014>
6. I. Harris, Y.L.Wang, H.Y. Wang, *International Journal of Production Economics* **159** (2015) <https://doi.org/10.1016/j.ijpe.2014.09.005>
7. L. Mironova, A. Ganieva, I. Rudaleva, *Transportation Research Procedia* **63** (2022) <https://doi.org/10.1016/j.trpro.2022.06.083>
8. M. Rosenko, E. Skrebets, *Transportation Research Procedia* **63** (2022) <https://doi.org/10.1016/j.trpro.2022.06.270>
9. M. Hossain, N.A. Mozahem, *Technological Forecasting and Social Change* **179** (2022) <https://doi.org/10.1016/j.techfore.2022.121668>
10. R. Strulak-Wójcikiewicz, N. Wagner, *Sustainable Cities and Society* **68** (2021) <https://doi.org/10.1016/j.scs.2021.102778>
11. A.V.Bodiako, Y.A. Krupnov, S.V. Ponomareva, T.M. Rogulenko, T.A. Kemkhashvili, Training of the digital workforce from today's youth: individualization versus standardization, *Education in the Asia-Pacific Region* **65**, 259-265 (2022)
12. N.A. Budarina, A.Yu. Kazakova, *Economics and business: theory and practice* **2-1(60)** (2020) <https://doi.org/10.24411/2411-0450-2020-10081>
13. E. A. Kuleshova, A. N. Kuskov, *Economics and Business: theory and practice* **12-2(70)** (2020)
14. Yu. V. Lazich, I. N. Popova, *Beneficium* **4(37)** (2020) <https://doi.org/10.34680/BENEFICIUM.2020>

15. P. Katyukha, A. Mottaeva, *Evolution of global oil benchmarks: new trends in pricing in the international oil market*, in E3S Web of Conferences **284** (2021)
<https://doi.org/10.1051/e3sconf/202128401008>
16. I. N. Makarov, E.V. Drobot, A.A. Avtsinova, *Economic relations* **10 (4)** (2020)
<https://doi.org/10.18334/eo.10.4.111306>
17. A. Mottaeva, L. Kopteva, *Problems of competitiveness of industries in ensuring the economic security of Russia*, in E3S Web of Conferences **284**, 11014 (2021)
<https://doi.org/10.1051/e3sconf/202128411014>
18. A. Nyangarika et al., *Frontiers in Environmental Science* **10** (2022)
<https://doi.org/10.3389/fenvs.2022.1031343>
19. K. V. Sayiyan, T.A. Ason, *Economic security* **4 (1)** (2021)
<https://doi.org/10.18334/ecsec.4.1.111255>
20. R. V. Fedorenko, I.A. Toymentseva, T. Tsegledi, *Humanities, socio-economic and social sciences* **1** (2020) <https://doi.org/10.23672/SAE.2020.1.53262>