

«Smart» transport and logistics complex as a factor of sustainable development of the region (on the example of the Volgograd region)

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Abstract. At the present stage of social development, which is forming a new high-tech world system with all its challenges and problems, it is necessary to provide all participants in social and economic relations with a single and convenient environment for interaction, to improve the level and quality of life, and to ensure sustainable development. «Smart city» technologies, and their further extrapolation to the scale of a regional entity – a «smart region» – make it possible to ensure sustainable development for all residents of the region and consumers of municipal and regional services – citizens, public and business organizations, as well as government. Due to the constant development of the transport industry and new opportunities for the transportation of passengers and goods, it is interesting to study the transport and logistics segment of the «smart region». It explains the relevance and practical significance of this study, which presents a theoretical and methodological substantiation of the formation of a «smart» transport and logistics complex with its positioning as a factor of sustainable development of the region, on the example of the Volgograd region. This approach is original, has a high degree of reliability, the ability to build and verify the forecast of the socio-economic development of the region. The developed model in the study represents the authors' vision of the development of the transport and logistics complex of the Volgograd region in the future, defines short, medium and long-term priorities, goals and objectives, proposes the main directions of development, mechanisms for achieving the set goals and objectives, taking into account the achieved level and identified problems. The results of approbation prove the expediency of its use in the development and scientific substantiation of the strategy of socio-economic development at the regional level.

Keywords. Transport, logistics, infrastructure, region, agglomeration, strategy, spatial development, socio-economic development.

1 Introduction

The Volgograd Region has the most important transit position among the regions of southern Russia and the Volga Federal District, it predetermines its position as a base in the country's transport system. A characteristic feature of the region is the passage of interregional and

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international routes on several types of transport through Volgograd region: road, rail, river and aviation. At the same time, the region currently does not fully realize its advantageous transport and geographical position due to the insufficient development of the transport infrastructure, which is a limiting factor in the socio-economic development of the Volgograd region.

The purpose of the authors' search is to develop theoretical and practical prerequisites for the formation of a «smart» transport and logistics complex as a factor of sustainable development of the region (on the example of the Volgograd region), following the conditions of comfort, safety, efficiency, environmental friendliness, accessibility based on a balanced transport policy.

To achieve this goal, the following tasks was formed and solved:

1) a general characteristic of the development level of the Volgograd region in comparison with the regions of the Southern Federal District of the Russian Federation is given;

2) a SWOT analysis of the Volgograd region was carried out through the prism of the development of the transport infrastructure of the region;

3) the detailed territorial-spatial characteristic of the Volgograd region and the characteristic of the transport infrastructure of the region are given;

4) a model of the formation of a «smart» transport and logistics complex as a factor of sustainable development of the Volgograd region has been developed, the main ways and mechanisms of its implementation have been determined;

5) the main directions of the territorial – spatial and transport development of the Volgograd region are determined within the framework of the authors' model by developing, respectively, the priorities of the territorial – spatial and transport development of the region;

6) the goals and objectives are highlighted and described, the target indicators are predicted, as well as the indicators of priority tasks «territorial and spatial development of the Volgograd region» and «development of the transport infrastructure of the Volgograd region» within the framework of the model for the formation of a «smart» transport and logistics complex as a factor of sustainable development of the Volgograd region.

The subject of the authors' research is the formation of a «smart» transport and logistics complex of the region through the creation of new or complex modernization of logistics and the development of a transport network, which must have the necessary capacity potential, will contribute to the territorial and spatial development of the region with the provision of continuous integral transport links with other regions of the country, with the prospects for its integration into the developed world transport systems.

2 Materials and methods

2.1 General characteristics of the development level of the Volgograd region

The Volgograd region is part of the Southern Federal District of the Russian Federation. The territory is 112.9 thousand sq. km (0.7% of the territory of the Russian Federation or 31st place in the Russian Federation). The population is 2.507.5 thousand people as of 01.01.2019, the population density is 22.2 people per 1 km². From 2010 to 2018 dynamics of the index of the GRP physical volume in the Volgograd region is characterized by a more moderate pace than the average for the Southern Federal District and the country. Only in 2014, the growth rate of 104.7% was higher. The economic recession was especially strong in 2015 – the GRP index amounted to 93.8% against 99.5% and 99.4% in the Southern Federal District and the Russian Federation, respectively. The comparison with other regions also shows that the region was unable to overcome the consequences of the crisis in 2008-2009. GRP growth lags behind the major regions for the period 2010-2018.

Manufacturing industry dominates in the sectoral structure of the Volgograd region's GRP (27.7% in 2018). At the same time, the share of transport services and storage (5.5%) turns out to be lower than in the regions of the Russian Federation (7.6%) and the Southern Federal District (10.7%), as well as the average level of the panel of regions used for comparison (7.2%). The results of a comprehensive analysis of the social and economic development of the Volgograd region, reflecting its place in the economy of the corresponding macroregion, in the economy of the Russian Federation, and the world economy are presented in Table 1.

Table 1. The share of the Volgograd region in various indicators of socio-economic development in the Southern Federal District, the Volga economic region and the Russian Federation, 2017 and 2018.

Indicator	2017			2018		
	Share in the Southern Federal District, %	Share in Volga economic District, %	Share in the Russian Federation, %	Share in the Southern Federal District, %	Share in Volga economic District, %	Share in the Russian Federation, %
Area	25.2	21.0	0.7	25.2	21.0	0.7
Population	15.3	15.8	1.7	15.3	15.8	1.7
The number of employed persons aged 15-72	15.5	15.2	1.7	15.7	15.6	1.7
GRP	14.4	12.6	1.0	14.6	12.3	1.0
Fixed assets	14.6	14.4	1.1	14.3	14	1.1
Mining	17.4	5.0	0.4	12.3	5.4	0.35
Manufacturing industries	27.7	16.1	1.87	29.1	18.3	1.98
Housing commissioning	8.4	8.5	0.9	6.4	7.2	0.8
Retail turnover	11.5	13.2	1.2	11.8	13.4	1.23
Fixed capital investments	13.3	12.4	1.2	12.6	12.0	1.03

Source: compiled by the authors based on Rosstat data.

According to the main socio-economic indicators of the RIA Rating agency in 2018, the Volgograd region took 27th place among all regions of Russia according to the integral rating (Rostov – 13, Samara – 12, Saratov – 34, Krasnodar – 9, Tatarstan – 5)¹. In terms of the achieved level of socio-economic development (GRP per capita) in 2018, the Volgograd region was ahead of the Tambov Region by 4%, the Saratov Region by 14% and the Altai Territory by 31%, lagging behind the average level in the Southern Federal District (by 5%).

Investments are the most important factor in increasing labor productivity and growth rates of GRP. The degree of depreciation of fixed assets was 55.8% in 2018, it significantly exceeds the average Russian level (46.6%) and the average level of the regions of the Southern Federal District (46.5%). It should also be noted that in the period from 2010 to 2018 the provision of the region's economy with investments was not high. On average, for the specified period, the volume of investments amounted to 23.2% of the GRP, it corresponds to the average Russian level (23.0%), but significantly lags behind the average level of the regions of the Southern Federal District (32.8%). The volume of investments in fixed assets amounted to 21.5% of the GRP in 2018, it exceeds the corresponding values for the country as a whole (20.9%) and below the values for the Southern Federal District (24.9%). According to this indicator, the region ranks 5th among the analyzed regions. Due to the low level of income, the Volgograd region is a region with a relatively cheap labor force and, therefore, low production costs at the average Russian level.

¹<http://riarating.ru/infografika/20180523/630091878.html>

Table 2. Place of the Volgograd Region in the Southern Federal District and the Russian Federation in terms of the development of the transport complex.

Indicators	Indicator of the Volgograd region				Place (rank) of the Volgograd region in the Russian Federation				Place (rank) of the Volgograd region in the Southern Federal District			
	Retrospective		Most relevant data		Retrospective		Most relevant data		Retrospective		Most relevant data	
	Year	Value	Year	Value	Year	Value	Year	Value	Year	Value	Year	Value
Density of public railway tracks, kilometers of tracks per 10,000 square kilometers of territory	2008	143	2018	143	2008	39	2018	40	2008	4	2018	5
Number of gas stations, pcs.	2013	505	2018	523	2013	19	2018	18	2013	5	2018	3
The share of public roads that do not match regulatory requirements, %	2008	47	2018	61.4	2008	59	2018	37	2008	2	2018	4

Source: compiled by the authors based on Rosstat data

The Table 2 presents that the region is among the leaders in the Southern Federal District, according to individual indicators of the development of the transport complex, - in particular, this is evidenced by the region's 3rd place in terms of the number of gas stations (and 19th place in the Russian Federation), and 4th place in the density of public railways (39th place in the Russian Federation). However, there is the 4th place among the regions of the Southern Federal District (59th place in the Russian Federation, respectively) in terms of the share of public roads that do not match regulatory requirements, it confirms an alarming situation in the field of road construction and the volume of its financing.

The main results of the SWOT analysis of the development of transport infrastructure (determining the strengths and weaknesses of the Volgograd region, opportunities and threats of the development of the region) are presented in Table 3.

SWOT analysis shows that there is a complexly structured system of resource constraints in the region. However, the most important limitation that hinders the development of the region can be singled out. There are limited opportunities and low investment efficiency (in relation to the SFD in general). The problem is in different spheres, including: the problem of the structure of investments: the bulk of investments are directed to projects related to the renewal of existing capacities. It is proposed to implement several small-scale large projects based on new (best available) technologies called "greenfield projects" [1]; low investment attractiveness of the Volgograd region, which is reflected in the ratings and existing expert assessments; limited possibilities of the regional budget, which is subsidized and characterized by a high burden in the field of social obligations.

Table 3. The strengths and weaknesses of the Volgograd region, opportunities and threats of the development of transport infrastructure.

Strengths	Weaknesses
<ul style="list-style-type: none"> - One of the largest regions of Russia in terms of population (18th place), the presence of a million-plus city. - The presence of a number of strong universities, colleges, leading R&D in the field of modern technologies and providing training for specialists in various fields of activity, including in the field of transport infrastructure. - The presence of enterprises that are part of large business structures of the federal and international level. - International relations of Volgograd, presence of loyal international donor markets (Germany, China). - Favorable transport and geographical position of the region, interregional and international routes passing through the territory of the region. - Diversified structure of industry (specialization in the production of oil products, chemical, metallurgical, food production). - The presence of raw materials and energy resources for the development of chemistry, petrochemistry, food production, as well as the growing demand abroad for the products of these industries. - The presence of deposits of construction materials. 	<ul style="list-style-type: none"> - High unemployment rate (structural, seasonal), high hidden unemployment and shadow employment. - Low level of real incomes of the population, which has been declining for several years. - Low labor productivity relative to the Russian Federation and the Southern Federal District in a number of sectors of the economy. - Low innovation and investment activity, lack of a developed system of innovation infrastructure. - Hypercentral position of the Volgograd transport hub. - The presence of «bottlenecks» on the railway network of the region. - High wear and tear of river rolling stock and the need to modernize waterways. - High depreciation of fixed assets, including morally and institutionally obsolete production assets. - Insufficient number of technological infrastructure facilities for the development of new industrialization, science-intensive and innovative production (including industrial parks, industrial technoparks, industrial clusters, technological business incubators). - A high share of raw materials in the structure of exports, a low share of highly processed products and high-tech goods in exports. - Low traffic capacity of the road network.
Opportunities	Threats
<ul style="list-style-type: none"> - Attracting a high-potential young population from the subjects of the Southern Federal District and other regions through the active development of the economy and social sphere. - Implementation of investment projects in the industries of specialization of the region (metallurgy, chemistry, petrochemistry, agriculture) and the creation of new highly paid and highly productive jobs. - Development of infrastructure for storage, processing, ensuring the sale of products in a period of high prices and a decrease in the influence of the seasonal factor, reduction of losses during storage. - Development of direct export of products, taking into account the development of agricultural logistics, the availability of railways and waterways. - Development of cruise tourism. - Increase of the transit role of the Volgograd region, both in cargo transportation to the ports of the Azov-Black Sea basin, and along the «North-South» corridor. 	<ul style="list-style-type: none"> - Outrunning development of neighboring regional centers and agglomerations. - Increased structural unemployment due to the closure of large non-competitive organizations. - Restrictions on the export of products due to non-compliance with international quality standards. - Loss of the tourist market due to the low level of tourist service. - International sanctions. - Low rating of investment attractiveness (IC6, No. 52, 2018²). - OPEC restrictions on oil production. - Bankruptcy of SMEs in the field of trade due to price dumping of federal and international trade networks. - Competition from neighboring regions, exporting regions and exporting countries of similar types of products.

Source: compiled by the authors.

In addition to financial and resource constraints, we have identified other factors that limit the possibilities of economic development: low provision and quality of basic infrastructure, the modernization of which, requires the need to attract financial resources; the presence of

²www.ra-national.ru/sites/default/files/analitic_article/IPR-6-06112018.pdf

a large number of «bottlenecks» on the road and rail transport networks; a high proportion of roads without asphalt pavement; the need to modernize the Volga-Don Canal; the elongated shape of the main transport hub, the lack of longitudinal highways.

At the same time, the region has a number of competitive advantages. The region has a unique resource potential, which can be regarded as a natural competitive advantage, which largely determines the economic specialization of the region. The Volgograd region also has rich mineral resources. The deposits of hydrocarbons, bischofite and potassium salts are the most significant: it creates the preconditions for the development of the corresponding branches of the chemical industry. The region has a diversified industrial production, although there are the deterioration of fixed assets and the loss of personnel potential in certain industries. The economic and geographical position of the Volgograd region as a whole can be characterized as favorable without peripherality. In the short term, Volgograd can turn into a powerful transport center and a key element of the Strategy for the development of Russian seaports in the Caspian basin, rail and road approaches to them in the period up to 2030³ due to its proximity to the Black and Caspian Seas.

2.2 Territorial and spatial characteristics of the Volgograd region

As practice shows, the policy of the region in the field of socio-economic development cannot be the same in relation to all municipalities. Therefore, the allocation of priorities and directions of spatial development of municipalities, first of all, requires taking into account the economic, geographical and social characteristics of the territory of each municipality [2]. At the same time, the important condition for enhancing spatial integration, production and social junction between municipalities is the development of infrastructure [3], first of all, road transport infrastructure: reconstruction of the Volgograd – Kamensk-Shakhtinsky – border with Ukraine, construction and reconstruction of sections of highway R- 22 «Caspian» – Moscow – Tambov – Volgograd – Astrakhan, creation of a container terminal and a logistics center in the river port of Volgograd, reconstruction of the Volga-Don canal waterworks and other projects.

Particular attention in the context of the spatial development of municipalities in the Volgograd region should be paid to the Sarpinsky island, which is the administrative part of the Kirovsky district of Volgograd. The island system «Sarpinsky-Golodny» is the environment-forming factor for the Volgograd – Volzhsky agglomeration – a «green wedge», the center where the natural base of the city is located. In this regard, it is necessary to strengthen the restrictions and regulation of the possible economic use of the territory of the islands in accordance with the approved scheme of ecological zoning of the territory. It is also necessary to strengthen monitoring of anthropogenic impact (including pollution) within the island system – dacha recreation, fishing tourism, etc., and take measures to create a tourist infrastructure which matches the environmental requirements for territories of this status [4, 5].

As a result of assessing the spatial development of the Volgograd – Volzhsky agglomeration there are the main conclusions made by us:

1. Strengths. In the spatial aspect, the Volgograd-Volzhsky agglomeration should first of all use the benefits of its geographical location on transport transit routes between the northern and southern parts of the country, as well as between Ukraine and Kazakhstan, between Russia and the countries of the Middle East (Iran, Syria, etc.). In this context, it is important to develop not only the ground road infrastructure, but also to expand the possibilities of using the Volga-Don Canal.

³Order of the Government of the Russian Federation of 08.11.2017 No. 2469-r «On approval of the Strategy for the development of Russian seaports in the Caspian basin, rail and road approaches to them in the period up to 2030».

2. Weaknesses. As a feature of the spatial structure of the Volgograd-Volzhsy agglomeration, it should be noted its «elongation» along the Volga bank and its general linear character (longitudinal-transverse), which is characterized by successively located strip planning formations: natural landscapes of the Volga-Akhtuba floodplain, industrial and residential areas, established lattices of transport and engineering communications. In this regard, the prospect of optimizing the planning structure (reducing distances and increasing the connectivity of the intra-agglomeration space) is associated with the development of ring structures. However, such a transformation of the structure requires the construction of an additional bridge across the Volga in the southern part of the agglomeration and, as a matter of priority, is only possible in the long term. In the medium term, the development of semi-circular structures is the most optimal. Also, the planning feature of the core of the agglomeration is its historical location on the banks of the Volga, the most valuable territories and industrial zones in terms of urban development potential and ecological framework. The gradual liberation of the Volga bank from production functions and their replacement with social and business, residential and recreational functions, for example, by analogy with the Moscow metropolitan agglomeration, is an extremely important task of the balanced spatial development of this territory. Thus, the priority tasks are the development of social infrastructure sectors – health care, education, culture, physical culture and sports, social services, in accordance with modern standards – the development of a comfortable urban environment, improving the transport connectivity of the territory.

3. Opportunities. It is necessary to develop a set of central functions to the surrounding territory within the Volgograd-Volzhsy agglomeration (the creation of large centers for the providing diverse socio-cultural services of interregional importance and ensuring their spatial and temporal accessibility by the most popular modes of transport). The assessment of the place of the Volgograd region in the hierarchy of interregional relations showed that in terms of transport, social potential and the potential of central functions, the Volgograd-Volzhsy agglomeration can develop as a medical, educational, cultural center outside its region for the Astrakhan region and the Republic of Kalmykia (Table 4), as well as export these types of services to foreign countries (Iran, etc.). It will be possible if there is the organization of full range of social services of the «capital» level on the territory of the agglomeration. The Volgograd-Volzhsy agglomeration can become a symbolic «Gateway to Persia» through the strengthening of socio-cultural, economic (increasing foreign trade turnover of products of the agro-industrial complex, equipment, and in the future – the development of junction in the oil-producing and oil-refining industries) and migration (attracting highly qualified migrants, consumers of medical and educational services) connections.

Table 4. Index of the potential of the central functions of the regions of the Southern microregion.

Rank among the regions of the Russian Federation	Region	Transport Potential Sub-Index	Social Potential Sub-Index	Potential index of central functions
6	Krasnodar region	0.519	0.062	0.582
20	Rostov region	0.293	0.090	0.383
32	Volgograd region	0.270	0.055	0.325
45	Republic of Crimea	0.186	0.041	0.227
44	Republic of Kalmykia	0.222	0.018	0.240
49	Astrakhan region	0.163	0.033	0.196
64	Republic of Adygea	0.110	0.007	0.117

Source: Authors' calculations based on Rosstat data.

4. Threats. The main threat is the weak position of the Volgograd-Volzhsy agglomeration in the macroregion when there is a competition with inter-macroregional centers (Rostov and Krasnodar agglomerations), as well as the high dependence of the sectors of specialization of the chemical clusters in Siberia, demand for mechanical engineering products and the state of

allied enterprises, etc.). The tools overcoming the threats are strengthening the factors of the migration attractiveness of the agglomeration (improving the quality of provided social services, the urban environment, the ecological situation, housing conditions, increasing the real income of the population, etc.) [6]. In the field of industrial production in this direction, a promising cluster policy is the promotion of the formation of chains with high added value of products of the industries of the main economic specializations, including the inclusion of promising allied enterprises from neighboring regions [7].

The organization of measures to reduce risks and expand opportunities in the spatial aspect of the development of the Volgograd-Volzhsy agglomeration should be based on a unified urban planning and socio-economic policy of the core city and surrounding territories, in connection with which it is possible to form a specialized government that performs recommendatory and coordinating functions between municipalities. The priority planning measures, in addition to the above, should include the following: optimization of the functional use of Volgograd and Volzhsky areas (reconstruction of urban development, renovation of depressed urban areas); the formation of new centers of economic activity outside the core; the creation of new industrial zones and the removal of enterprises from the central regions which are adjacent to the Volga; the development of recreational areas (for example, the formation of a garden and park zone along the embankment), the system of «green wedges», etc. [8].

The development of the Volgograd-Volzhsy agglomeration is impossible without the creation of a joint transport and engineering infrastructure, which implies, in addition to the above planning solutions, also the modernization of public transport (including, to enhance intra-agglomeration connectivity, it is possible to create a cable car across the Volga by analogy with Nizhny Novgorod) [9]. The completion of the construction of the Volgograd bypass will allow the entire transit flow to be taken outside the core of the agglomeration and significantly reduce internal economic distances. The reconstruction of the Volgograd-Kamensk-Shakhtinsk highway will allow the Volgograd-Volzhsy agglomeration to be connected by direct road communication with the Rostov agglomeration and the M-4 highway, which will significantly improve the transport accessibility of the Volgograd region for the regions located in the gravitational zone of the M-4 «Don» highway. Also, the construction and reconstruction of sections of the R-22 «Caspian» – Moscow – Tambov – Volgograd – Astrakhan highway have decisive importance for the development of the agglomeration. An important event is the modernization of the dam of Volzhsky Hydroelectric power station. The creation of a multimodal transport hub that will combine railway, aviation and road transport will enhance multimodal integration, increase logistics productivity, and reduce infrastructure congestion, which will create additional competitive advantages for the Volgograd region as a whole. The multimodal center will become an important infrastructure facility in the development of the North-South international transport corridor, as well as the possibility of increasing exports from the Volgograd region, primarily to Asian countries.

2.3 Characteristics of the transport infrastructure of the Volgograd region

In the current version of the Transport Strategy of the Russian Federation⁴ and other strategic documents in the field of transport, most of the target indicators are associated with «volumetric» characteristics – kilometers of new roads, railways, an increase in the capacity of seaports, etc. Our proposed approach includes the development of infrastructure as a whole and each project in particular, each regulatory change should be related to specific results in terms of user satisfaction, contribution to the achievement of the goal and specific tasks of the country's socio-economic development. The feasibility and priority of transport projects and regulatory changes should be assessed through the prism of contributions to accelerated

⁴Transport Strategy of the Russian Federation for the period up to 2030. – Ministry of Transport of the Russian Federation (mintrans.gov.ru). – Access mode: <https://mintrans.gov.ru/documents/3/1009>.

economic growth and concrete positive changes for users. It does not mean that all transport projects should exclusively address the problem of stimulating economic growth - many projects have a purely technological or social basis. But the highest priority should be those which make it possible to increase the productivity of the economy, its investment attractiveness, and make a significant contribution to the development of human capital [10].

The main trend in the coming years in the development of the transport system will be the modernization of the country's mainline infrastructure. During 2018, the Comprehensive Plan for the Modernization and Expansion of the Mainline Infrastructure for the period up to 2024⁵ was developed, which reflects the main results which should be achieved within the specified time frame. The implementation of new transport projects will be aimed at improving the quality of the country's transport infrastructure, increasing the export of transport services, increasing the efficiency of the freight logistics indicator (Logistics Performance Index), increasing the transport mobility of the population, and increasing the level of transport provision of the constituent entities of the Russian Federation [11]. Table 5 shows the dynamics of key indicators for the development of the region's transport infrastructure.

Table 5. Dynamics of key indicators for the development of transport infrastructure in the Volgograd region in 2012-2018.

Indicators ⁶	2012	2013	2014	2015	2016	2017	2018	2018 in % to 2012
The share of the length of public roads of regional or intermunicipal importance on the territory of the Volgograd region that meet the regulatory requirements for transport and operational indicators, in the total length of these highways, %	33.0	36.0	36.5	37	37.5	38	38.6	116.97
Mortality from road traffic accidents (per 100 thousand population)	13.5	12.6	13.55	13.6	13.27	12	10.39	76.96
Passenger turnover of public road transport, mln seat-km.	1947	1050	900	620	546	549	585	30.05
Passenger turnover of public commuter rail transport, mln seat-km.	3.8	3.8	3.8	4.1	4.2	4.4	5.1	134.21
The length of the network of public highways of regional or intermunicipal, as well as local importance, km.	23863	25369	25514	25680	26644	26702	26739	112.05
The volume of commissioning after the construction and reconstruction of public roads of regional or intermunicipal, as well as local importance, km.	no data	36.4	3.8	49.9	68.0	79.3	44.2	–

Source: Compiled by the authors.

As can be seen from the presented Table, there is an increase of the key indicators of the development of transport infrastructure in the Volgograd region, in particular, it is worth noting an increase in the studied period by 16.97% in the share of the length of public roads of regional or intermunicipal importance in the territory of the Volgograd region that meet regulatory

⁵The Comprehensive Plan for the Modernization and Expansion of the Mainline Infrastructure for the period up to 2024. Approved by the order of the Government of the Russian Federation of September 30, 2018 N 2101-r (with changes on July 4, 2020). – Access mode: <http://docs.cntd.ru/document/551365461>.

⁶Provided according to the data of the State Program «Development of the transport system and ensuring road safety in the Volgograd region».

requirements, as well as an increase of 34.21% in the passenger turnover of public suburban railway transport. As negative trends, we attribute a 70% decrease in the passenger turnover of public road transport, which is obviously caused by the growing motorization of the population and the competitive pressure of alternative modes of transport. Road carriers should introduce development tools based on intensification, including improving the quality level (updating the rolling stock at a new technological level) and the safety of the provided services, first of all, it applies to small and medium-sized enterprises, which grew in recent years due to extensive factors (an increase in the number of operated routes and the vehicle fleet) [12].

In this study, we have identified a number of key problems of the transport infrastructure of the Volgograd region.

The problems of road transport in the Volgograd region include: 1) A low level of development of road infrastructure (low share of paved roads); 2) An imperfect network of highways, affecting the overload of the Volgograd traffic flows, including transit due to the lack of a bypass of the city [13]; 3) A high degree of elongation of the main transit hub; 4) A small number of longitudinal highways on the territory of the Volgograd transport hub; 5) A high level of motorization in the region, which leads to high risks in the field of road traffic and active formation of traffic jams.

The problems of railway transport include several key problems: 1) The growth of freight rail transit flow through the territory of the region, which affects the formation of new «bottlenecks» in the region's railway network; 2) The absence of a second main track or electrification on some main railways [14]; 3) Congestion of railways within the Volgograd-Volzhsky agglomeration; 4) Insufficient development of intracity rail passenger traffic in Volgograd.

Water transport also has several key problem: 1) A significant decrease in the transportation of goods and the turnover of inland water transport in recent years; 2) Reducing the transshipment of goods in the main river ports of the Volgograd region; 3) Limiting the capacity of the Volga-Don shipping canal, which can be solved by modernizing the Volga-Don shipping canal to increase the possibilities of freight traffic, including transit ("The Comprehensive Plan for the Modernization and Expansion of the Mainline Infrastructure for the period up to 2024" includes a project on the inland waterway transport for the creation of the Bagaevsky hydroelectric complex on the Don River. However, the potential of its creation will not be fully realized with the constant capacity of the Volga-Don shipping canal. For this reason, it is necessary to initiate the introduction of this project into the "Comprehensive Plan for the Modernization and Expansion of the Mainline Infrastructure for 2021 -2022); 4) High level of wear and tear of passenger ships; 5) Insufficient transport accessibility of Sarpinsky island.

Other problems of the functioning of the region's transport system include: 1) Lack of qualified personnel in the field of logistics; 2) Lack of training of specialists with secondary specialized education in logistics.

3 Results and discussion

The model for the implementation of a «smart» transport and logistics complex, as a factor of sustainable development of the Volgograd region, is shown in Fig. 1.

The model represents the authors' vision of the development of the transport and logistics complex of the Volgograd region in the future, defines short, medium and long-term priorities, goals and objectives, proposes the main directions of development, mechanisms for achieving the goals and objectives, taking into account the achieved level and identified problems.

Achieving the goals and solving the problems of forming a «smart» transport and logistics complex as a factor of the sustainable development of the Volgograd region will take place through the implementation of basic development priorities considering the implementation of the corresponding measures within the established time frame until 2030. Organizational

and managerial tools for implementing the model presuppose the development of a project management system, as well as the creation of new development institutions and improvement of the existing ones.

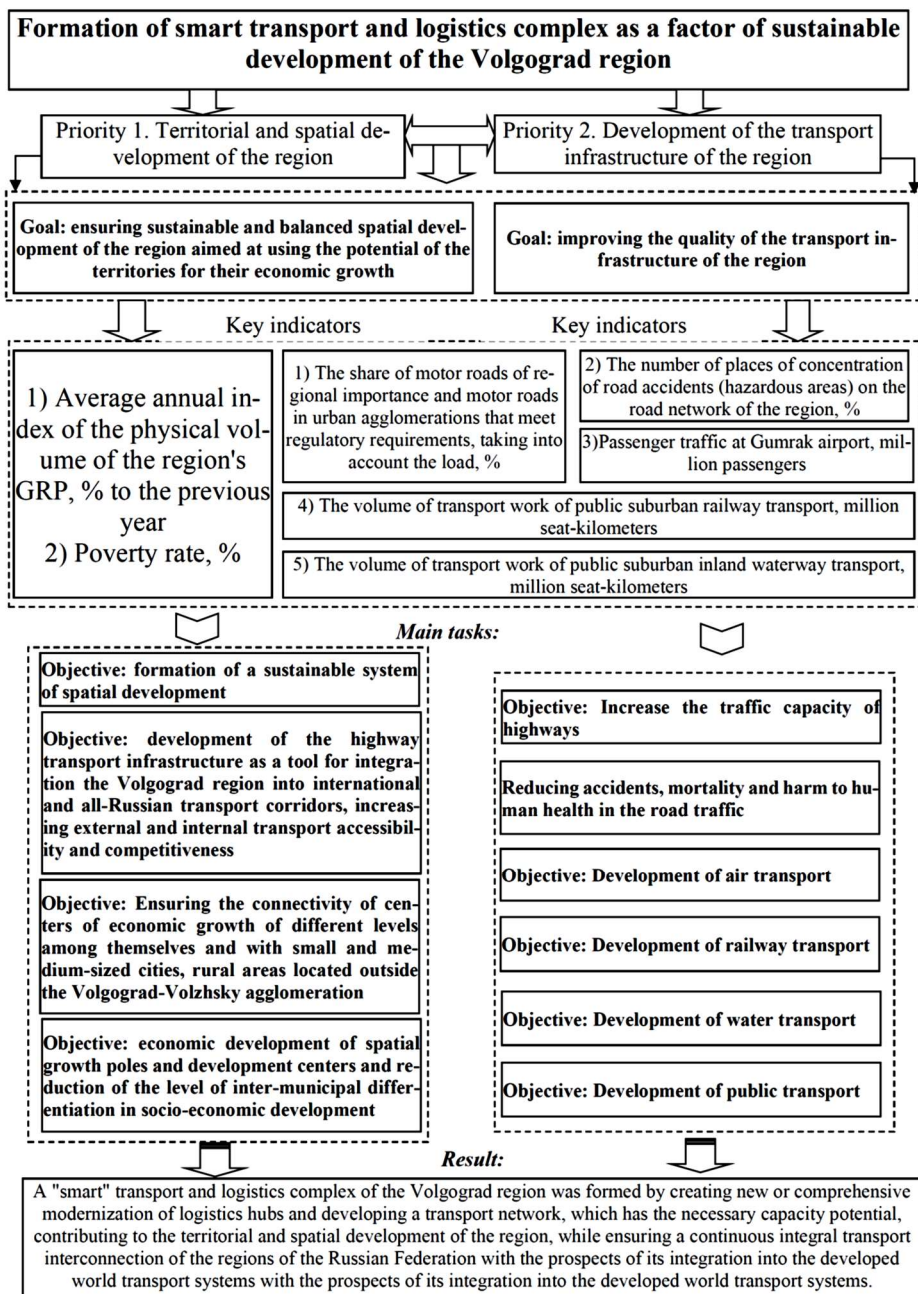


Fig. 1. The model of the formation of a «smart» transport and logistics complex as a factor of sustainable development of the Volgograd region and ways of its implementation (compiled by the authors).

The main instrument for financing the costs of implementing the model can be state programs of the Volgograd region, which include various activities, including activities for the

implementation of regional projects. A predictive assessment of financial resources from budgets of all levels, the amount and schedule of financing of activities which are necessary for the implementation of our proposed model for the development of the transport infrastructure of the Volgograd region (taking into account probable scenarios), is presented in Table. 6.

Table 6. Scenario assessment of financial resources required to implement the model for the formation of a «smart» transport and logistics complex as a factor of sustainable development of the Volgograd region, million rubles.

Scenario	Stage 1 (2019-2021)	Stage 2 (2022-2024)	Stage 3 (2025-2030)	Total
Inertial	80637	39245	72253	192135
Base	142337	199175	77009	418521
Optimistic	144185	246538	313060	703784

Source: compiled by the authors.

It is noted that the inertial scenario presupposes that the conjuncture of external markets remains unfavorable for the main goods exported by the region. At the same time, sanctions remain and are tightened, it negatively affects investment activity, restricts access to foreign technologies and the ability of enterprises to renew fixed assets. Domestic demand remains low with inactive bank lending. The structure of the economy is dominated by industries with low added value. In the context of limited budgetary opportunities for financing important investment and infrastructure projects, there is a slow renewal of fixed assets of enterprises, transport and social infrastructure.

In the baseline scenario, it is supposed that the influence of the negative external background will weaken over time. At the same time, certain structural reforms, reforms of interbudgetary relations, which stimulate interregional competition, are being carried out. It allows the Volgograd region to use natural advantages of the region, to realize the transport, logistics and recreational potential. In the framework of intensified investment activity and cheapening of credit resources, it will allow industries to grow at a faster pace, including industries with high added value and oriented towards foreign markets. It also allows to modernize all sectors of the economy, increase labor productivity. The implementation of the most important investment and infrastructure projects will be ensured, including the mechanism of public-private partnership.

The optimistic scenario assumes a favorable external background, positive dynamics of world commodity and financial markets and, if not the lifting of sanctions, then their nominal nature. Favorable external economic conjuncture and the reduction of geopolitical risks, including structural and institutional reforms, restart the processes of socio-economic development. At the same time, the structure of the economy is changing - industries with high added value are growing at a faster pace, the digital economy and the service sector are developing. The scenario presupposes that the industries which have received a pulse for development as a result of the import substitution policy, will be able to maintain positive dynamics even after the cancellation of counter-sanctions. Expansion of the budgetary possibilities of the region and a decrease of discount rate of percent, launch investment processes. It makes it possible to rapidly update fixed assets, introduce advanced technologies, including imported technologies against the background of favorable conditions on the foreign exchange market.

The priority forms of attracting funds from private companies and credit organizations for co-financing, including repayable co-financing, activities (projects) within the framework of the implementation of the model are the conclusion of a concession agreement, an agreement on public-private or municipal-private partnership, a life cycle contract, that is, a contract, providing for the purchase of goods or work (including design, construction of an object that should be created as a result of the work if it is necessary), subsequent maintenance, repair, and, if it is necessary, operation and (or) disposal of the delivered goods

or created one as a result of the work performance of the object. We also note that in order to attract extra-budgetary funds and competencies of the private sector for the implementation of the infrastructure and social tasks of the model, the possibilities and tools of public-private partnership can be widely used [15].

Next, let us turn to the characteristics of each of the development priorities indicated in the authors' model.

3.1 Determination of priorities for the territorial and spatial development of the Volgograd region

The key advantage of the Volgograd region is its geographical location and the strategic role of the «gateway» of the south of Russia with access to Iran, Iraq through the Caucasus and India, through Kazakhstan. The transport frame of the Volgograd region, the main elements of which are the federal highways R-22 «Caspian» and A-260, a large railway junction in the South of Russia, navigable rivers Volga and Don, connected by the Volga-Don canal, which has access to five seas (Caspian, White, Baltic, Black and Azov), the international airport «Volgograd», provides favorable conditions for the transportation of various cargoes from the ports of European states to the shipping zones of Africa, the Near and Middle East. The strategy of Spatial Development of the Russian Federation for the period up to 2025⁷ defines Volgograd as one of the elements of the modern settlement system of the upper hierarchical level, that is, one of the centers of the all-Russian level of the settlement system.

The main problems of the spatial development of the Volgograd Region as a whole reflect national trends and are associated with uneven development of territories, imbalance in supply and demand for social, engineering and information infrastructure, poor transport connectivity within the region and with neighboring territories, significant intraregional differences in the level of socio-economic development, including the lagging of living standard of significant part of the population living in rural areas from the living standard of urban residents with a low level of comfort of the urban environment in most cities of the region, etc.

The peculiarities of the spatial development of the Volgograd region are the underutilized potential of the main transport infrastructure in terms of water and air transport, low wages and continued migration outflow, especially of young people, also to other regions of the Southern Federal District. The goal of the priority "Territorial and spatial development" is to ensure sustainable and balanced spatial development of the region, aimed at using the potential of the territories for economic growth and at reducing inter-municipal differences in the level and quality of life of the population. Indicators of goals and objectives within the framework of this priority are presented in Table 7.

It is necessary to consider the detailing of the target indicators and their expected changes:

- the average annual index of the physical volume of the gross regional product of the Volgograd region, percent to the previous year: an increase from 99.2 in 2018 to 102.7 in 2030;
- poverty rate, %: decrease from 13.4 in 2018 to 6 in 2030.

The points of economic growth of the Volgograd region are:

1) the Volgograd-Volzhsky agglomeration, which is a promising large center of economic growth in the Russian Federation (the list of growth centers includes cities that form large urban agglomerations and the largest urban agglomerations that will contribute more than 1% to the economic growth of the Russian Federation annually) and a service center for the South macroregion;

2) the subregional center of economic growth – an economic growth corridor on a section of the territory along the «Caspian» Volgograd-Mikhailovka highway, which includes the city

⁷Order of the Government of the Russian Federation of 13.02.2019 No. 207-r «On Approval of the Strategy for the Spatial Development of the Russian Federation for the Period until 2025».

of Uryupinsk, the single-industry town of Frolovo and the single-industry town of Mikhailovka, which received the status of the territory of advanced socio-economic development;

3) the promising subregional center of economic growth – a mineral resource center in the Kotelnikovsky district;

4) municipalities of the Volgograd Region specializing in agriculture – promising centers of economic growth of the constituent entities of the Russian Federation – agro-industrial centers that will contribute more than 0.2% to the economic growth of the Russian Federation annually.

Table 7. Goals and objectives, target indicators, indicators of the tasks of the priority «Territorial and spatial development» of the Volgograd region.

Goals and objectives	Indicator name, unit of measurement	2017	2018	2019-2021	2022-2024	2025-2030
Goal: Ensuring sustainable and balanced spatial development of the region, aimed at using the potential of territories for economic growth and reducing inter-municipal differences in the level and quality of population's life	Average annual index of the physical volume of the GRP of the Volgograd region, % to the previous year	99.9	99.2	102.0	102.4	102.7
	Poverty rate, %	13.6	13.4	10	7.2	6
Objective: Formation of a sustainable system of spatial development	The share of municipalities provided with relevant, automatically updated documents of strategic planning, territorial planning and urban planning zoning in a machine-readable format, % of coverage	0	0	25	50	100
Objective: Economic development of spatial growth poles and development centers and reduction of the level of inter-municipal differentiation in socio-economic development	Inter-municipal differentiation by average monthly wages, %	16	14,7	14,6	14,5	14,2
	Inter-municipal differentiation by the volume of shipped goods of own production, works and services performed on their own (excluding small businesses), %	86.4	97.3	90.6	83.8	81.3
	Inter-municipal differentiation according to the average provision of housing per resident of the region, %	15.1	15.3	13.7	12.3	10.2

Source: compiled by the authors.

To implement the tasks related to the priority «Territorial and spatial development», a number of measures corresponding to them can be considered:

1. Objective: Formation of a sustainable system of spatial development:

- improving the institutional organization of the spatial development of the Volgograd region and the implementation of a unified urban planning policy, including the creation of situational centers of municipalities, editing the territorial planning scheme (TPS) of the Volgograd region, creating an electronic version of the TPS with the possibility to update data through integration with state information systems of the region, updating the sections of regional standards for urban planning, preparation of land planning projects for the placement of objects of regional importance [16];

- preservation of the natural and ecological base of the region and ensuring sustainable use of natural resources, including the introduction of an adaptive landscape model for the use of land resources.

2. Objective: Development of the highway transport infrastructure as a tool for including the Volgograd region into international and all-Russian transport corridors, increasing external and internal transport accessibility and competitiveness (the task is shown further in the priority “Development of the Volgograd region transport infrastructure”).

3. Objective: Ensuring the connectivity of economic growth centers of different levels among themselves and with small and medium-sized cities, rural areas located outside the Volgograd-Volzhsy agglomeration (the objective is shown further in the priority «Development of the transport infrastructure of the Volgograd region»).

4. Objective: Economic development of spatial growth poles and development centers and reduction of the level of inter-municipal differentiation in socio-economic development:

- development of a promising center of economic growth of federal significance – the Volgograd-Volzhsy agglomeration, aimed at the formation of an agglomeration as a service center for the provision of social services in the Southern microregion and for the economic development of the Volgograd region (including through the formation of high-tech science-intensive industries of federal significance and industries with high added value)⁸;

- development of a subregional center of economic growth - an economic growth corridor on a section of the territory along the «Caspian» Volgograd-Mikhailovka highway, including the city of Mikhailovka, the city of Frolovo and the city of Uryupinsk, including promoting the modernization of city-forming enterprises that produce products that are competitive on the world and (or) Russian markets;

- development of small towns and rural areas, including subsidizing regular public transport routes for remote areas, the introduction of new transport technologies (car sharing, vehicle sharing systems) [17].

3.2 Determination of priorities for the development of transport infrastructure of the Volgograd region

Currently, there are several main directions for the development of transport infrastructure, largely associated with scientific and technological progress and improving the quality of life in developed countries [18]. These trends include: 1) The introduction of automated, intelligent transport systems and new management systems in the field of transport infrastructure [19]; 2) Increasing requirements for transport safety; 3) Increasing requirements for environmental friendliness and energy efficiency of transport systems; 4) Intensive development of multimodal transport and logistics systems for freight and passenger transportation; 5) The effect of «space compression» due to the growth of the speed of transport communication in the world [20].

⁸We mean that the Volgograd-Volzhsy agglomeration in the period up to 2030 will include the following municipalities: the hero city of Volgograd, Volzhsky City, Sredneakhtubinsky, Gorodishchensky, Svetloyarsky, Leninsky, Dubovskiy municipal districts.

Table 8. Goals and objectives, target indicators, indicators of the tasks of the priority «Development of transport infrastructure» of the Volgograd region.

Goals and objectives	Indicator name, unit of measurement	2017	2018	2019-2021	2022-2024	2025-2030
Goal: Improving the quality of transport infrastructure	The share of regional motor roads and highways in urban agglomerations that meet the regulatory requirements, taking into account the congestion, %	38	39.5	47.4	55	73.7
	The number of places of concentration of road traffic accidents (accident-dangerous sections) on the road network of the Volgograd region, %	100	93.4	73.8	49.2	25
	Passenger traffic of Gumrak airport, million passengers for the last year of the stage	1.014	1.148	1.39	1.7	2.26
	The volume of transport work of public suburban railway transport, million seat-kilometers in the last year of the stage	4.4	5.1	5.9	6.1	6.5
	The volume of transport work of public suburban inland waterway transport, million seat-kilometers for the last year of the stage	0.01	0.01	0.01	0.02	0.03
Objective: Increase the capacity of highways	The share of regional roads operating in overload mode in their total length, %	0.61	0.61	0.55	0.55	0.55
Objective: Reducing accidents, mortality and harm to human health in road traffic	The number of deaths in road traffic accidents per 100 thousand population, people	12	10.39	9.02	3.43	3
Objective: Development of air transport	Freight traffic of Gumrak airport, thousand tons for the last year of the stage	1.6	1.8	2.2	2.7	3.8
Objective: Development of railway transport	Weekly number of suburban train trips	387	361	403	431	459
Objective: Development of water transport	Weekly number of public inland waterway trips	320	320	360	400	400
Objective: Development of public transport	The volume of transport work of public road transport, million seat-kilometers for the last year of the stage	549	585	640	645	650
	Passenger traffic of the city electric transport in the city of Volgograd, million passengers for the last year of the stage	32	38	39	40	41

Source: compiled by the authors.

Taking into account the above world trends in the development of transport infrastructure, the goal of the priority «Development of transport infrastructure of the Volgograd region» is to improve the quality of regional transport infrastructure. The implementation of the main measures in the field of transport infrastructure until 2030 should affect the change in the target indicators of transport activities on the territory of the Volgograd region. The main indicators of the general goal are presented below in Table 8.

According to the data in Table 8, the following key indicators of the priority of transport development are expected to change:

- the share of regional highways and highways in urban agglomerations that meet regulatory requirements, taking into account the congestion, %: an increase from 39.5 in 2018 to 73.7 in 2030;
- the number of places of concentration of road traffic accidents (dangerous areas) on the road network of the Volgograd region, %: a decrease from 93.4 in 2018 to 25 in 2030;
- passenger traffic of Gumrak airport, million passengers for the last year of the stage: an increase from 1.148 in 2018 to 2.26 in 2030;
- the volume of transport work of public suburban railway transport, million seat-kilometers for the last year of the stage: an increase from 5.1 in 2018 to 6.5 in 2030;
- the volume of transport work of suburban inland waterway transport for general use, million seat-kilometers for the last year of the stage: an increase from 0.01 in 2018 to 0.03 in 2030.

To implement the tasks related to the «Transport Infrastructure» priority, a number of appropriate measures can be envisaged:

1. Objective: Increase the capacity of highways:
 - construction of highways, including «Bypass of the city of Volgograd», «Bypass of the Gorkovsky microdistrict», «Bypass of Dubovka», «Bypass of the urban-type settlement Novy Rogachik», construction of a bridge across the river Volga in the city of Volgograd, completion of the construction of highways «3rd Prodolnaya highway» and «Zero Prodolnaya highway» in Volgograd;
 - reconstruction of highways, including completion of the reconstruction of the R-22 «Caspian» highway;
 - transfer of motor roads to federal ownership;
 - creation of mechanisms for economic stimulation of the safety of regional and local roads;
 - creation and development of digital tools to improve the efficiency and safety of the road transport sector in the Volgograd region;
 - reduction of budgetary costs for the construction and operation of highways.
2. Objective: Reducing accidents, mortality and harm to human health in road traffic:
 - construction of overpass interchanges and reconstruction of bridge crossings, including the reconstruction of bridge crossings on the Volga-Don navigable canal;
 - ensuring the safety of participation of the region's population in road traffic.
3. Objective: Development of air transport:
 - development of cargo air transport, including the construction of a cargo terminal and completion of the reconstruction of the passenger terminal of Gumrak airport;
 - development of passenger air transport.
4. Objective: Development of railway transport:
 - construction of additional main tracks and new railway lines, including the construction of the second main track of the Trubnaya – Baskunchak – Aksaraiskaya railway section, the development of the Tatyanka Yuzhnaya – Kanal'naya railway section within the Volgograd-Volzhsky agglomeration;
 - modernization and reconstruction of railway lines;
 - complex development of the highway infrastructure on the territory of the Volgograd region, including the creation of a multimodal transport and logistics center of the network in the area of the railway station named after Maxim Gorky;
 - increasing the connectivity and accessibility of territories by railway transport.
5. Objective: Development of water transport:
 - reducing the length of sections of inland waterways limiting their carrying capacity, including initiating the inclusion of the project for creating the second line of the Volga-Don shipping canal in the federal «Comprehensive plan for the modernization and expansion of the main infrastructure until 2024»;

- construction and reconstruction of river transport infrastructure, including reconstruction of piers in Volgograd and Dubovka, construction of a pier structure in Kamyshin in the water area of the Volgograd reservoir;
 - increasing the connectivity and accessibility of territories by water transport, including the development of car ferry crossings to Sarpinsky island in Volgograd and Kamyshin.
6. Objective: Development of public transport:
- reduction of budget expenses for the maintenance of public transport, including the conclusion of concession agreements in the field of development of public transport and intelligent transport systems;
 - digital development of public transport, including the creation of a control network for traffic lights with the function of adaptive control [21, 22], the creation of a paid parking space in Volgograd and Volzhsky, the creation of a «Regional Transport Management Center», implementation of a unified non-cash payment system throughout the region (a unified social transport card and a unified «electronic wallet»);
 - increasing the efficiency and attractiveness of urban transport, including the construction of transport and transfer hubs in the city of Volgograd, the purchase of new tram cars for use in Volgograd and the city of Volzhsky, the purchase of trolleybuses with increased autonomous running (electric buses with dynamic charging);
 - increasing the efficiency and attractiveness of intercity public transport, including the reconstruction of bus stations and bus stations in the Volgograd region, the purchase of new rolling stock on gas engine fuel for servicing intercity bus routes [23].

Table 9. Breakthrough investment projects in the development of transport infrastructure of the Volgograd region.

№	Name of the project	Implementation period (years)	Description of the project
1	Construction of the highway «Bypass of Volgograd»	2024 (Stage I) 2030 (Stages II-III)	The project involves the construction of a high-speed road around the city of Volgograd, which will make it possible to move transit flows outside the residential area, which will significantly improve the traffic situation in the city. The total length of the future road will be 71.4 km, while the project will be implemented in three stages. At the first stage (until 2024), 12.1 km of the road will be built in the southern part of the city from the R-22 highway (direction to Astrakhan) to the Kirov settlement. The second and third stages (from R-22 to Moscow until A-260 and from A-260 to the Kirov settlement, respectively) will be implemented by 2030. The project will be financed from the federal budget.
2	Creation of a multi-modal transport and logistics center of the core network in the area of the railway station named after Maxim Gorky	2022 (Stage I) 2024 (Stage II) 2030 (Stage III)	The project involves the creation on the territory of the Volgograd region near the railway station named after Maxim Gorky transport and logistics center, which is a basic element of the corresponding transport and technological systems for the transportation of goods, including a group of specialized and universal terminals, as well as the necessary engineering, transport and administrative infrastructure for servicing transit, export-import and regional cargo flows and allowing to implement advanced logistics solutions and provide participants in the transportation process with a range of value-added services.

Source: compiled by the authors.

The largest investment projects, the implementation of which is provided for at various stages of transport infrastructure development, are presented in Table 9.

These projects can be characterized as «breakthrough» in the development of the transport infrastructure of the Volgograd region, radically affecting the state of the industry and the region as a whole. Their implementation will significantly increase the export-import potential of the region and will contribute to the integration of the Volgograd region into the system of international transport corridors.

4 Conclusion

Achieving the goals and objectives of development of the transport complex of the Volgograd region, which are presented in this study, will allow transforming the regional transport complex into a new qualitative state – a «smart» transport and logistics complex, which is a factor in the further sustainable development of the region. This is evidenced by the growth of qualitative and quantitative forecast indicators, in particular, by 2030 it is expected:

- A 1.9 times growth of the share of regional motor roads and highways in urban agglomerations that meet regulatory requirements, taking into account the congestion;
- Increase of the road network with new highways, improvement of the quality of existing highways;
- Reduction of up to 6% of the share of freight vehicles in the total volume of traffic on regional or intermunicipal roads carrying goods exceeding the permissible weight and overall dimensions without compensation for damage caused to roads;
- Improving road safety, reducing congestion, increasing the throughput of the transport system and reducing the cost of its maintenance;
- Reducing to 38% the share of road accidents caused by the abnormal condition of highways;
- Partial replacement of budgetary costs for the construction and operation of highways with extra-budgetary investments, reduction of total capital and operating costs for the road network while improving its quality and safety;
- Improving road safety, reducing child road traffic injuries;
- Increasing the length of railways in the region and increasing the length of modernized railways;
- Development of integrated logistics and attraction of large logistics operators to the region;
- Improving the transport accessibility of urban areas;
- Providing modern infrastructure for water transport, increasing their profitability due to the possibility of providing non-transport services in the buildings of river terminals.
- In general, the creation of new transport and logistics centers and complexes and reconstruction of existing ones, as well as the balanced development of transport and logistics services are the most promising directions of region development. The development of the transport and logistics sector should ensure: attraction of additional freight and passenger traffic; development of services in the field of transport and logistics; formation of a modern multimodal complex, functioning as a single transport and logistics system. Thus, the region will be able to realize the potential of its advantageous transport and geographical location, which will be the most important factor mediating the social and economic development of the Volgograd region.

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