The road infrastructure development impact on the economy of the region

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Abstract. The subject of the research is the road infrastructure development; the purpose of the study is to analyze the road network of the region as an element of its road infrastructure, to analyze the development of the road infrastructure using quantitative and qualitative criteria based on the regional road network current state assessment (using the example of the Krasnodar Territory). The construction and reconstruction of a capital construction object - highways will lead to an improvement in the conditions for the implementation of transport links, a decrease in accidents and an increase in traffic capacity, which will increase the circulation speed on this road section, and, as a result, reduce transport costs.

1 Introduction

The state of the road infrastructure in modern conditions affects the economy of the region and this is due to a number of reasons. First of all, this is insufficient financing of public services, the absence of commercialization mechanisms, simultaneously with imbalances in the federal and municipal budgets, leads to an underproduction of services, which means incomplete satisfaction of the population needs, a decrease in its mobility and, ultimately, welfare.

Most of these problems cannot be solved by the private sector and the market, which requires the active participation of municipalities in the production of public goods and services. However, the forms of this participation can be different and depend, first of all, on the division of powers, financial responsibilities and interests between the public and private sectors. It is obvious that the substantiation of effective mechanisms of commercialization is the most urgent task here.

However, the difficulty lies in the selection of a competitive regime, such as contracting, interaction of the municipality with the private sector and its implementation in an optimal way. This makes it necessary to justify the implementation and identify the features of the implementation of organizational, economic and management measures aimed at the formation and development of the road network in the region.

Regions play a key role in the construction of infrastructure, especially the roads, and they, as a rule, are developed within the framework of federal programs. In the area of transport infrastructure development, the priority areas of the ministry are to promote

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uniform policies and standards, coordinate efforts at various levels of government and create federal infrastructure. The Transport Strategy of Russia for the period up to 2030, approved by the Government of the Russian Federation at the end of last year, has recently received an update. The key factor in the implementation of this strategy is the state program for the transport system development. Coordination Councils for the transport hubs' development in the Southern Federal District are a good example of effective and efficient cooperation between the ministry and the regions.

Using the example of the Krasnodar Territory, we will consider the state of the road infrastructure and determine how the state of the roads affects the economy of the region. Krasnodar Territory has an advantageous location and is a connecting artery between major cities of the country. The length of highways in the Krasnodar Territory is 32,000 km. With a hard surface, 26,000 km of which about 13,000 km are roads with an improved surface. About 3759.5 km of roads do not meet the regulatory requirements of the local roads [1]. It would be worth noting that this indicator has decreased by 3% over the past 3 years. This was achieved at the expense of the federal budget in the implementation of long-term (regional and municipal) targeted programs, which made it possible to improve the quality of road surfaces and reach a new level of development of the region's transport infrastructure.

But nevertheless, as follows from the data presented, the existing state of public highways of local importance is characterized by serious shortcomings and does not correspond to the needs for transportation.

The main problem of the network of local highways of the region is, first of all, in the presence of numerous sections of roads that do not have a hard surface and do not meet regulatory requirements due to the inconsistency of the main technical parameters of the existing or expected future traffic intensity, or due to inconsistency with other transport and operational condition of roads.

In order to determine the level of quality and traffic flow, a list of requirements for the road networks has been developed:

- means of organizing the circulation of pedestrians and cyclists;
- average daily traffic intensity of freight and passenger traffic for calculating the number of lanes (with a population of more than 50 thousand people, a multi-lane road is being designed);
- -ensuring road safety, reducing accidents;
- vehicle impact devices;
- transit potential and passenger traffic directly depend on the roads' quality. This requirement demonstrates the direct dependence of road transport on the quality of roads, and the possibility of financial support for roads, on the economic development of the region, due to the profit from transport;
- quality of coverage, for safe traffic on all sections of the road network.

The research of domestic scientists - Z. Magrupov, A. Eremeev, I. Tapilin [2, 3] is devoted to the development of transport infrastructure. The mechanism of the road network development in the region was investigated in the works of I. Evstigneev, T. Zolotukhin, N. Fatakhutdinov [4,5].

2 Results

Any region is interested in developing and improving the conditions for the implementation of transport links, increasing the throughput of high-speed roads, reducing accidents and the negative impact of transport on the environment, increasing the speed of vehicles and reducing transport costs. All these conditions form a characteristically new structure for the

development of road infrastructure in the region and pose qualitatively new tasks in the study of the effectiveness of the analyzed process in the field of demand and satisfaction with the road infrastructure of the region by road users. And on the other hand, a comprehensive analysis of the dissatisfactioncriteria with the road infrastructure is necessary, since it is necessary to determine the internal effects that hinder the road network development and, as a consequence, the region's economy. Therefore, it is necessary to create such economic conditions necessary for updating and realizing the potential of the road infrastructure, which would give a vector of development to various sectors of the economy by improving the quality of transportation.

The expected economic effect received by road users as a result of the implementation of design solutions in the construction or reconstruction of roads is the sum of the transport effect [6] (Fig. 1).

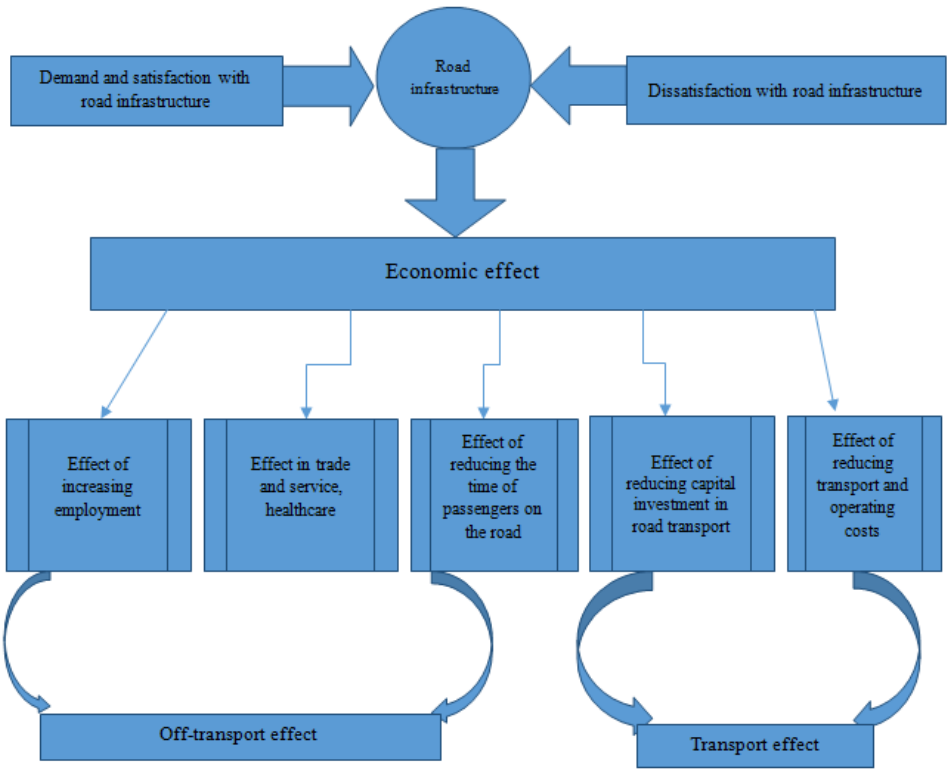

Fig. 1. Impact of economic effect on the road infrastructure development**.**

The transport effect consists of the effect obtained from a reduction in transport and operating costs due to a decrease in the cost of vehicle mileage per 1 km, the effect of a reduction in capital investments in road transport and annual additional capital investments that ensure an increase in the volume of freight traffic. The off-transport effect from improving road conditions is formed from the effect in the sphere of enhancing entrepreneurial activity in trade, in health care, in increasing employment of the population and reducing the time spent by passengers on the way due to an increase in traffic speeds and a decrease in losses from road accidents while improving the conditions and increasing traffic comfort [7].

To effectively solve social problems, it is necessary to pay attention to the fact that investments in road infrastructure contribute to the entrepreneurial activity activation, reduce the negative impact of road infrastructure on the environment, and reduce the

number of accidents. But nevertheless, the main goal of the arrangement and reconstruction of roads remains the capacity of transport, which solves a number of problems, such as reducing travel time, traffic intensity, the possibility of increasing speed. As an example, let us compare the traffic intensity before the reconstruction of the M-4 "Don" road segment from km 1459 + 805 to km 1542 + 215 and further. At the same time, it is necessary to take into account and analyze the size of traffic flows for each of the road sections, depending on the type of transport (trucks, cars).

To determine the seasonal coefficient of fluctuations in traffic intensity, the distribution of traffic intensity was analyzed depending on the type of transport [8]. The results of traffic intensity monthly measurements carried out by the road maintenance service made it possible to calculate the ratio of monthly traffic intensity by transport mode to the average annual value.

Table 1. Results of control measurements of traffic intensity, June 2015

Location of the counting point (highwayM-4 "Don")	Time spending accounting		Intensity circulation, units.	Adjoining road	
	day	hour	Towards Novoros-siysk	Name	Intensity circulation, units
1	2	3	4	5	6
1. km 1503+750	15.07.2015	09:20–10:20	1605	highway M-4 "Don" Aderbievka	255
2. km1504+600	15.07.2015	10:25–11:25	2123	highway M-4 "Don Dzhanhot"	1066
				Exit to Aderbievka village	31
	15.07.2015	15:00–16:00	2172	Highway M-4 "Don Dzhanhot"	1116
				Exit to Aderbievka village	22
3. km1504+850	15.07.2015	13:45–14:45	2339	Exit to PR	50
4. km1505+800	15.07.2015	16:10–17:10	1407	Exit to Gelendzhik (Lunac-harsky st.)	1566

Source: compiled by the author based on the research results

After the M-4 Don road segment reconstruction as of 2020, it can be said that the throughput and traffic intensity increased in the studied sections by 30%. Moreover, the data obtained in the course of measuring the traffic intensity, broken down by the carrying capacity of trucks in the main directions, indicate a significant road traffic of the freight train, especially of medium and low carrying capacity.

Also, when comparing the speed of cars before and after the road segment reconstruction, they differ by an average of 30 km / h, while the analysis of the route plan

elements' lists was carried out, which made it possible to determine the actual values of the calculated speeds for the characteristic sections of the road by the curves' radii values in the plan, as well as on serpentine sites. The values of the calculated speeds after reconstruction are given in Table 2.

Table 2. Estimated speeds on the studied road sections

Road Portion	Speed standard, km / h		
	Main portion	Difficult portion	Serpentine portion
km 1459+805 - km 1466+100	80	60	-
km1466+100 - km 1468+200	90	60	-
km1468+200 - km 1473+500	70	60	-
km1473+500 - km1476+500	70	50	-
km 1476+500 - km1485+300	90	60	-
km 1485+300 - km1488+500	90	60	-
km 1488+500 - km 1494+900	70	50	30
km 1494+900 - km 1499+400	80	60	-
km 1499+400 - km1505+650	90	60	-
km1513+450 - km1519+400	90	70	-
km 1531+650 - km1536+700	80	60	20

Source: compiled by the author based on the research results

Taking into account the analysis of the road technological features, the analysis of the traffic intensity on the investigated section of the M-4 "Don" highway from km 1459 + 805 to km 1542 + 215 [9] (Table 3) was carried out, and also the efficiency was considered on the basis of economic research taking into account the toll road bypassing Novorossiysk in the direction of Abinsk - Kabardinka.

The analysis of the reduced average annual daily intensity on the investigated section of the M-4 "Don" highway from km 1459 + 805 to km 1542 + 215 under the existing conditions, taking into account the toll road bypassing Novorossiysk and Abinsk - Kabardinka, showed that the throughput of vehicles for this direction reduces travel time and makes it possible to reduce traffic intensity and is one of the factors in maintaining the Krasnodar Territory in economic equilibrium.

Table 3. Traffic intensity with current results and taking into account the use of a toll road

Track span name	Length, km	Average annual daily traffic intensity, car / day			
		Freight	Cars	Buses	Total
1	2	3	4	5	6
The beginning of the route (Arkhipo-Osipovka village) - Pshada village adjoining the entrance to Beregovoe village and Betta village	18.10	2050 – 1850	4750 - 4550	350	7150 - 6750
Adjacent to the entrance	23.20	1950 –	4700 -	250 -	6900 - 7250

Track span name	Length, km	Average annual daily traffic intensity, car / day			
		Freight	Cars	Buses	Total
to the village of Beregovoe and the village of Betta - the village of Vozrozhdenie		2000	4950	300	
Vozrozhdenie - adjoining the entrance to the village. Divnomorskoe and the village of Praskoveevka	3.50	2150 – 2800	6600 - 9250	400 - 600	9150 - 12650
Adjacent to the entrance to the village. Divnomorskoe and the village of Praskoveevka - the beginning of the bypass of Gelendzhik	1.40	3800	16000	1200	21000
Bypass of Gelendzhik	7.75	4950	18850	850	24650
Gelendzhik	1.65	6400 – 4700	31200 - 22400	2050 - 1150	40300 - 28500
Gelendzhik - the beginning of the bypass of the village of Kabardinka	5.85	4000 – 3750	15600 - 14350	4000 - 3750	20550 - 18900
Bypassing the village of Kabardinka	3.50	2950 – 2800	10350 - 9250	400 - 300	13650 - 13350
The end of the village of Kabardinka bypass - the beginning of the city of Novorossiysk	9.70	3150 – 3200	10650 - 3150	600 - 600	14400 - 14000
Novorossiysk (street Sukhumskoe highway)	5.86	3600 – 5850	11850 - 17750	1900 - 2250	17350 - 25850
2015					
The beginning of the route (Arkhipo-Osipovka village) - Pshada village adjoining the entrance to Beregovoe village and Betta village	18.10	3500 - 3450	10850 - 10550	700	15300 - 14700
Adjacent to the entrance to the village of Beregovoe and the village of Betta - the village of Vozrozhdenie	23.20	3650 - 3750	10750 - 12800	500 - 600	14900 - 17150
Village Vozrozhdenie - Adjacent to the entrance	3.50	3900 – 5000	14250 - 19700	650 - 1000	18800 - 25700

Track span name	Length, km	Average annual daily traffic intensity, car / day			
		Freight	Cars	Buses	Total
to the village. Divnomorskoe and the village of Praskoveevka					
Adjacent to the entrance to the village Divnomorskoe and the village of Praskoveevka - the beginning of the bypass of Gelendzhik	1.40	6650	33550	2100	42300
Bypass of Gelendzhik	7.75	8600	39400	1400	49400
Gelendzhik	1.65	11250 – 8200	65900 - 46850	3600 - 2000	80750 - 57050
Gelendzhik - the beginning of the bypass of the village of Kabardinka	5.85	7000 – 6650	32900 - 30600	1650 - 1400	41550 - 38650
Bypassing the village of Kabardinka	3.50	5550 – 5350	23200 - 21150	750 - 600	29500 - 27100
The end of the village of Kabardinka bypass - the beginning of the city of Novorossiysk	9.70	5950 – 6050	22950 - 23000	1100	30000 - 30150
Novorossiysk (street Sukhumskoe highway)	5.86	6350 – 9900	25400 - 36850	3150 - 3800	34900 - 50550

Source: compiled by the author based on the research results

According to Table 3, it can be seen that the traffic intensity is decreasing, which leads to a change in road congestion. The bypass toll road has been shown to be effective in reducing the traffic flow.

3 Conclusion

There is a positive growth dynamic in the return of the effect in the future, which gives an opportunity to conclude that improving the roadsquality will lead to a decrease in road accidents, increase the mobility of the population, lead to the transitive potential development and, as a consequence, to the development of the region. The non-transport effect from improving road conditions in the field of non-material production is formed in a number of industries, which has a beneficial effect on the activities of the business sector and forms favorable institutional conditions for the development of the region. Of course, it is too early to talk about the return of funds for such roads' construction, since self-sufficiency for such projects is prolonged. And nevertheless, we can say with confidence about the need to implement such important and strategic objects, since thereby the road infrastructure is being formed, which affects the development of the entire Krasnodar Territory.

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